

# Diabetic Foot Syndrome

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## Bibliography

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## German Diabetes Association: Clinical Practice Guidelines

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## NOTICE OF UPDATE

The DDG practice recommendations are updated regularly during the second half of the calendar year. Please ensure that you read and cite the respective current version.

## UPDATES TO CONTENT COMPARED TO THE PREVIOUS YEAR'S VERSION

No changes affecting the basic approach to the treatment of diabetic foot syndrome.

## Definition

Diabetic foot syndrome is understood to be all pathological changes in the foot of a person with diabetes mellitus. These include pre-ulcerous lesions such as abnormal corneal callouses. Ulcers or necroses usually develop as a result of repetitive trauma with limited sensation of pressure and pain in the context of diabetic polyneuropathy (e. g. in the form of high pressure and shear stress, especially in foot and toe deformities). In Germany, more than 50% of all cases are characterized by a relevant peripheral arterial occlusive disease (PAOD), whose symptoms (claudication, pain at rest) are often masked by the polyneuropathy.

## Epidemiology

The most significant manifestations of diabetic foot problems are ulcerations, deforming changes of the foot skeleton (Charcot foot) and amputations.

The annual rate of new cases of acute diabetic foot syndrome (DFS) is about 2%. The probability of DFS over the entire lifetime of a person with diabetes is 19–34%.

For many years, Germany was at the top of the European amputation rates, but a recent large nationwide study showed a decrease in major and minor amputations in the diabetic population compared to the non-diabetic population. The result of this study thus confirms a positive trend that has already been observed in smaller and regional studies in recent years [1]. 65–70% of all amputations are still performed in patients with diabetes mellitus.

## Risk factors

Foot lesions or acquired foot deformities in people with diabetes are the result of a multifactorial event with the following major causal factors:

- Neuropathy (sensory, motor, autonomous)
- Peripheral arterial occlusive disease (PAOD)
- Limited joint mobility (LJM)
- Pressure deformities (e. g. due to unsuitable footwear, foot and/or toe deformities, obesity)
- Corn/callus formation as a sign of incorrect pressure distribution
- Biopsychosocial factors (e. g. depression, neglect, beliefs about illness, lack of social support)

## Examination

All people with diabetes should have their feet and shoes examined regularly (► **Tab. 1**).

Each foot examination is an integral part of the controls in the corresponding disease management programs (DMPs) for type 1 and type 2 diabetes and must include at least the following points:

- Specific anamnesis (presence of burning or stabbing pain, paresthesia, numbness, absence of any sensation),
- Bilateral foot examination: skin status (integrity, turgor, perspiration, calluses), musculature, deformities, mobility, skin temperature, etc. and
- Checking of pressure sensation with a 10 g monofilament and/or testing of vibration sensation with the Rydell-Seiffer tuning fork, palpation of foot pulses (posterior tibial artery, dorsalis pedis artery).

### Pressure sensation

The filament is applied with light pressure so that it bends slightly, creating a pressure of 10 g. If this pressure is no longer perceived, the sensation of pressure is already considerably reduced, and the natural protective function is therefore no longer reliable. Scarred or callused skin is unsuitable for testing.

### Foot pulses

Finding the foot pulses by touch depends on the room temperature. In the case of non-palpable pulses on the feet, the pulses of the popliteal and femoral arteries must be examined. Palpable foot

► **Tab. 1** Control intervals of foot examinations depending on the individual risk status.

Risk category	Risk profile	Examination
0	No peripheral neuropathy	Yearly
1	Peripheral neuropathy	Every 6 months
2	Peripheral neuropathy with PAOD and/or foot deformity	Every 3–6 months (specialist)
3	Peripheral neuropathy and ulcer or amputation in the medical history	Every 1–3 months (specialist)

PAOD = peripheral arterial occlusive disease

pulses do not exclude PAOD! Further examinations are recommended (see evidence-based guideline “Diagnosis, therapy, follow-up and prevention of diabetic foot syndrome” of the German Diabetes Association (DDG), [www.AWMF.de](http://www.AWMF.de)).

- Measurement of the arterial occlusion pressure over the dorsalis pedis artery and the posterior tibial artery,
- Determination of the ankle-brachial index (ABI) and
- Better: determination of the toe-brachial index (TBI).

## PAOD

The usual symptoms of PAOD (intermittent claudication, pain at rest, pathological skin temperature and color) are often absent in patients with concomitant neuropathy. The extent of the risk is therefore underestimated. ABI as a screening method is of limited use in the presence of an autonomic neuropathy with associated media sclerosis and the resulting incompressibility of the arteries of the lower leg and foot. The most reliable combination of findings for the exclusion of a relevant PAOD in DFS is a toe-brachial index  $\geq 0.75$  and the detection of triphasic Doppler signals [9]. Further examination procedures include color-coded duplex ultrasound (CCD), magnetic resonance imaging (MRI) of the pelvic and leg vessels and, if necessary, digital subtraction angiography (DSA) in readiness for intervention. Before and after angiography, adequate hydration must be ensured to avoid contrast agent nephropathy. Where renal insufficiency is present, MRI should only be performed after weighing the benefits and potential risk (low!) of gadolinium-induced systemic fibrosis on a case-by-case basis. In such cases, DSA using CO<sub>2</sub> for contrast can be performed. Computer tomographic angiography (CTA) is not suitable for people with diabetes due to the high contrast medium requirement and the low separation precision between vascular lumen and calcified plaques, especially in the arteries of the lower leg. All national/international guidelines clearly stipulate that this reduced blood flow must be corrected if vascular involvement occurs, ideally by means of minimally-invasive procedures (PTA) or vascular surgery. If both are no longer possible (non-reconstructable extremity, no-option), many alternative methods for the improvement of arterial perfusion are offered and often applied without any proof of effectiveness [2].

Good clinical practice in diabetic foot syndrome always means following interdisciplinary and multi-professional treatment paths. These include, at minimum, the coordinated combination of wound debridement, infection treatment, stage-appropriate wound management, targeted pressure relief, and arterial revascularization and surgical measures.

**Master Data**

**Foot documentation form of the DDG Working Group on the Foot**

<b>Institution:</b>
General practitioner: ..... ..... Referring practitioner: ..... .....

**Anamnesis:**

**Important long-term diagnoses:**

.....  
 .....

**Previous foot lesions (year)**       none      **Foot operations (year)**       none

.....  
 .....

Antibiotic preliminary treatment :  no  yes ..... MRSA ...  currently  in the past ....

**Previous orthopedic shoe provision:**

- no special shoes       shoe protection       custom-made shoes       orthopedic cushioning       DAF
- decompression shoe
- provision is sufficient       provision is insufficient because .....

**Angiology:**

PAOD present       no       yes      Critical ischemia:       no       yes

Bypass (from ... to )	R	L		
PTA	R	L		
<b>Pulse status</b>	<b>Right</b>	<b>Left</b>	<b>Angiography right</b>	<b>Left</b>
Femoral artery				
Popliteal artery				
Dorsalis pedis artery				
Posterior tibial artery				
Claudication				

**Doppler/duplex findings**

Last dopper/duplex on .....

<b>Closing pressure [mmHg]</b>	<b>Right</b>			<b>Left</b>			<b>Flow profile</b>			
							<b>Right</b>			<b>Left</b>
Brachial artery										
Popliteal artery										
Dorsalis pedis artery										
Posterior tibial artery										
Fibular artery										
DI/cm (pole test)	<input type="radio"/> 0	<input type="radio"/> 50	<input type="radio"/> 70	<input type="radio"/> 0	<input type="radio"/> 50	<input type="radio"/> 70	Other: (e.g. TcPO <sub>2</sub> )			
Doppler sounds										
<b>Chronic venous insufficiency</b>	<b>Right</b>						<b>Left</b>			
CVI classif./PTS										

**► Fig. 1 a** Foot documentation sheet – page 1. Source: Foot Working Group of the DDG. MRSA = Methicillin-resistant Staphylococcus aureus; DAF = diabetes adapted footbed; PAOD = peripheral arterial occlusive disease; PTA = percutaneous transluminal angioplasty; DI = doppler index; TcPO<sub>2</sub> = transcutaneous oxygen pressure; CVI = chronic venous insufficiency; PTS = post thrombotic syndrome

**Foot findings:** from:.....  no lesion

Lesion age: .....  recurring time without recurrence ..... months

**Lesion:** suspected trigger .....

Localization/description/size

Right							<input type="radio"/> Photo	Left							<input type="radio"/> Photo
Stage of wound healing															
Wagner ulcer classification system															
	0	1	2	3	4	5		0	1	2	3	4	5		
A							A								
B							B								
C							C								
D							D								
PEDIS	P	E	D	I	S		P	E	D	I	S				
DOAP															
Sanders															
Levin															

**Deformities:**  none

	Right	Left
Hallux valgus		
Claw/hammer/overriding toes		
Other		

**Limited joint mobility**  none

Hallus limitus		
Plantar fibromatosis		
Other		

**Neurology:** PNP with loss of sensation present  no  yes

	Right			Left		
Vibration [x/8]	D1	Mall	Tib	D1	Mall	Tib
Achillis reflex can be triggered	No	Weak	Strong	No	Weak	Strong
10g Semmes Weinstein Filament	MTB1	MTB5	D1	MTB1	MTB5	D1
Neuropathic symptoms (score)						
Others						

**Diagnoses:**

.....

.....

.....

.....

Date: ..... Signature: .....

► **Fig. 1 b** Foot documentation sheet – page 2. Source: Foot Working Group of the DDG. PEDIS = Perfusion, Extent/size, Depth/tissue loss, Infection and Sensation (senses); DOAP = diabetic osteoarthopathy; D1 = first distal phalanx; Mall = malleolus; Tib = tibialis; MTB = metatarsal bone

If a patient is diagnosed with a lesion as part of diabetic foot syndrome, it should be classified according to the extent of tissue damage and the presence of infection and/or ischemia (Wagner classification, combined Wagner-Armstrong classification) (► **Fig. 1a, b**, ► **Tab. 2**, ► **Tab. 3**). The current version of the IWGDF guideline includes for the first time a chapter on the classification of diabetic foot ulcers [3]. The implementation of the recommendations formulated therein is currently being discussed in the extended board of the Diabetic Foot Working Group in the DDG.

► **Tab. 2** Classification according to Wagner.

Wagner grade	Extent	Measure
0	No ulcer but possible foot deformation or cellulitis	Regular check-up of the feet
1	Superficial ulcer	The focus is on pressure relief and local wound treatment
2	Deep ulcer extending into joint capsule, tendon, or capsule	The focus is on pressure relief and local wound treatment
3	Deep ulcer with abscess, osteomyelitis, infection of joint capsule	Infection control; with systemic antibiotic treatment and consequent pressure relief, smaller osteomyelitic foci usually heal, larger foci usually have to be resected; X-ray control lags somewhat behind the actual condition of the bone; if the clinical findings are improved, the continuation of the antibiotic treatment can be made additionally dependent on signs of inflammation in the blood; normally, even small processes require antibiotic treatment of 6 and more weeks
4	Limited necrosis of forefoot or heel area	Treatment is mainly concerned with keeping the level of amputation as distal as possible and preventing ascending infection; in the case of PAOD, angiography should be performed before each amputation
5	Necrosis of the entire foot	Treatment is mainly concerned with keeping the level of amputation as distal as possible and preventing ascending infection; in the case of PAOD, angiography should be performed before each amputation

► **Tab. 3** Wagner-Armstrong Classification. Possibilities for description of diabetic foot syndrome using the combined Wagner-Armstrong classification.

Wagner grade	0	1	2	3	4	5
Armstrong classification						
A	Pre- or post-ulcerous foot	Superficial wound	Wound to the level of tendons or capsule	Wound to the level of bones and joints	Necrosis of parts of the foot	Necrosis of the complete foot
B	With infection	With infection	With infection	With infection	With infection	With infection
C	With ischemia	With ischemia	With ischemia	With ischemia	With ischemia	With ischemia
D	With infection and ischemia	With infection and ischemia	With infection and ischemia	With infection and ischemia	With infection and ischemia	With infection and ischemia

## Treatment

Only a multidisciplinary, multi-professional and trans-sectoral approach to the treatment of foot ulcers can significantly reduce the frequency of amputations. Essential components of the treatment of diabetic foot ulcers are:

- Metabolic optimization and treatment of internal underlying diseases,
- Infection control,
- Debridement of avital tissue parts,
- Effective pressure relief,
- Local wound treatment appropriate to the stage of the disease,
- Therapy of vascular diseases,
- Surgical correction of foot deformities and/or misalignments and
- Patient training.

### Metabolic optimization and treatment of internal underlying diseases

Metabolic optimization is indispensable for optimizing immune competence, improving hemorheology and thus microcirculation, and preventing progressive pathological glycation. Accompanying diseases, which impair

- Immune competence,
- Hemoperfusion or
- Tissue oxidation

should be treated appropriately.

### Infection

The diagnosis of infection is made clinically in the presence of systemic or local indications. The extent of infection in diabetic foot syndrome is classified as mild, moderate and severe, and life-threatening or non-life-threatening (1 REF\_Ref114856208\n\h ► **Tab. 4**). Inpatient admission is indicated in the case of severe (and possibly moderate) infection (measures: adequate fluid intake, metabolic control, calculated, if possible targeted antibiotic therapy, drainage, complete pressure relief, and further surgical measures, if necessary). Infection with multi-resistant bacteria worsens the prognosis. It is essential to prevent infections from colonization and contamination. To avoid resistance development, treatment should be carried out according to the criteria of antibiotic stewardship (ABS): the correct indication, the correct drug (targeted culture-controlled administration), the correct form of application, and the correct dose. In patients with chronic recurring foot lesions or recurring antibiotic treat-

► **Tab. 4** Clinical classification of foot infections. Data according to [4, 5].

Clinical manifestation of the infection	Severity of infection	PEDIS classification
Wound without suppuration or signs of inflammation	Not infected	1
Presence of $\geq 2$ signs of inflammation (suppuration, redness, (pressure) pain, warmth or sclerosis), but each sign of inflammation $\leq 2$ cm around the ulcer; infection is limited to the skin or superficial subcutaneous tissue; no other local complications or systemic disease	Mild	2
Infection (as above) in a patient who is systemically healthy and metabolically stable, but exhibits $\geq 1$ of the following characteristics: signs of inflammation which extend $> 2$ cm around the ulcer, lymphangitis, spread under the superficial fascia, abscess in deep tissue, necrosis and extends to muscle, tendon, joint or bone	Moderate	3
Infection in a patient with systemic signs of infection or unstable circulation (e. g., fever, chills, tachycardia, hypotension, confusion, vomiting, leukocytosis, acidosis, severe hyperglycemia or azotemia)	Severe	4
Clinical manifestation of the infection	Severity of infection	PEDIS classification
The presence of critical ischemia shifts the severity of the infection (in terms of prognosis) towards "severe", but may reduce the clinical signs of infection. PEDIS = Perfusion, Extent/size, Depth/tissue loss, Infection and Sensation (senses).		

ment, it is recommended that an personal antibiotic booklet is carried 1 REF\_Ref114856157 \n \h [9].

## Wound debridement

Wound debridement is important for the effectiveness of other treatment measures.

- Mechanical debridement (e. g. using scissors, scalpels, spoon excavators, curette, ultrasound): removal of necrotic debris in the wound bed, debridement of the wound edges if necessary. Before debridement is performed, adequate arterial perfusion should be ensured. Anesthesia is rarely necessary due to the neuropathy; strictly aseptic conditions are usually not required due to the existing bacterial colonization.
- Biomechanical debridement: liquefaction of wound debris and necrotic tissue by proteases in medical maggot secretion (fly larvae).

## Pressure relief

In principle, it must be clear to all those involved (patients, relatives, practitioners) that effective pressure and shear force relief suitable for everyday use is of crucial importance. At the same time, this is a recurring challenge due to the usually-present loss of protective sensation (LOPS). According to the current recommendations of the International Working Group on the Diabetic Foot

(IWGDF), the following measures for effective pressure relief should be considered [9]:

1. Means of choice for neuropathic plantar ulcer: total contact cast (TCC), non-detachable, knee-high or walker, which is made not detachable.
2. If there are contraindications for the measures from number 1 or if these are not tolerated by the patient, then an ankle-high aid is used as a substitute. The patient should always be informed about the importance of wearing the aid.
3. If other options for biomechanical relief are not available/do not work, then consider felted foam padding, but always together with suitable footwear.
4. For non-plantar ulcerations, removable ankle-high aids, shoe fittings, etc.
5. Consider surgical measures to relieve pressure (e. g. tenotomies, position corrections, (pseudo)exostosis removal, Achilles tendon extension)! For effective pressure relief, regular removal of corns/calluses is also mandatory.

## Local wound treatment

For chronic, non-ischemic wounds, the rules of stage-oriented wound treatment (fluid and temperature management) apply. The wound surface should be thoroughly cleaned at each dressing change. The choice of dressing in an individual case should be based on wound size, exudate volume, presence or absence of signs of infection, available evidence [6–10] and cost-effectiveness criteria.

## Therapy of vascular diseases

In the presence of PAOD, the indication for revascularization procedures (surgical or endoluminal procedures) must be made aggressively if the foot lesions do not heal or if there is a risk of amputation. Without sufficient blood circulation, wound healing is not to be expected. In particular, the possibility of arterial revascularization must be considered if a foot lesion shows no tendency toward healing within 4 weeks despite maximum wound therapy efforts [9].

Vascular surgery and endovascular interventions complement each other. Their use depends on the distribution pattern of PAOD, the length of the vascular occlusions, and the expertise and equipment of the practitioner, as well as the presence of a suitable epifascial leg vein as bypass material. In most cases, percutaneous transluminal angioplasty (PTA) should initially be preferred, provided that both revascularization procedures are technically available [11].

## Training

Training patients with the aim of ulcer prevention may be a short-term effective intervention option to reduce both amputations and the ulcer rate. Repeated instruction of caregivers is equally important.

## Amputation

If an amputation is necessary, the extent of the amputation should be kept as small as possible in order to preserve weight-bearing areas and the best possible functionality. Prior to each amputation, a meaningful vascular diagnosis must be performed, and the necessity of revascularization must be assessed. A major amputation (amputation above the ankle) as a primary treatment measure

► **Tab. 5** Stages of diabetic neuropathic osteo-arthropathy (DNOAP) according to Levin.

Stage	Clinical indications
I	(Acute stage): foot red, swollen, overly warm (X-ray image may still be normal)
II	Bone and joint changes, fractures
III	Foot deformity: flat foot, later cradle foot due to fractures and joint disintegration/damage
IV	Plantar foot lesion

► **Tab. 6** Stages of diabetic neuropathic osteo-arthropathy (DNOAP) according to Sanders.

Type	Affected structures
I	Interphalangeal joints, metatarsophalangeal joints, metatarsals
II	Tarsometatarsal joints
III	Naviculocuneiform joints, talonavicular joint, calcaneocuboid joint
IV	Ankle joints
V	Calcaneus

is rarely indicated. As of May 2021, the second opinion before amputation for DFS has been officially included in the second opinion procedure. One of the essential demands of the Oppenheim Declaration at the founding of the Working Group Diabetic Foot in the DDG of 1993 receives official and legal basis with the obligation to provide information about the right to obtain a qualified second medical opinion within the framework of the standard care of the GKV. All professional groups involved in this topic, such as general practitioners, angiologists, surgeons, dermatologists, diabetologists, vascular surgeons, internists, orthopedists, trauma surgeons and also master orthopedic shoemakers and podiatrists who are committed to foot and limb preservation in interdisciplinary care structures, should be involved in the second opinion procedure before amputation in patients with diabetic foot syndrome at an early stage. (12). Reference is also made to certified foot treatment facilities of the Foot Working Group in the DDG ([www.ag-fuss-ddg.de](http://www.ag-fuss-ddg.de)) for searching for experienced and competent doctors.

### Diabetic neuropathic osteo-arthropathy (DNOAP) (Charcot foot)

DNOAP is associated with the disintegration of single or multiple joints and/or bones (classification by stage of progression and localization pattern: ► **Tab. 5**, ► **Tab. 6**). In addition to the obligatory neuropathy (irrespective of its genesis), repeated unnoticed traumas are the main causes of its development.

An early diagnosis in the acute phase of the disease (active Charcot's foot) is decisive for the prognosis. X-rays of the foot in 2 planes are not sufficient to detect and differentiate this early stage of DNOAP (stage 0 according to Chantelau/Edmonds). An MRI is usually the decisive method for early detection of the disease in addition to the clinical examination which includes determining the surface temperature on both sides. The primary therapy consists of a consistent immobilization of the affected foot (see section "Pressure relief"). At the same time, it is important to ensure adequate shoe and insole care for the foot on the opposite side. There is a relevant risk

for the development of DNOAP on the opposite side as well! After the disappearance of inflammatory signs of disease and stabilization of the findings, it is considered an "inactive Charcot foot".

### Prevention

Prevention of initial occurrence (active Charcot arthropathy) as well as the prevention of recurring events and amputations are of vital importance. Preventative measures include:

- Identification of high-risk patients (medical history: previous foot lesion or amputation; findings: clinical examination including consideration of biomechanical aspects, monofilament, pulse palpation),
- Regular examination of feet and footwear including measurement of skin temperature in patients with sensory neuropathy,
- Suitable footwear, including custom-made insoles, if necessary
- Consideration of and treatment of other pathological changes in the foot,
- Complex podological treatment,
- Training of all participant, including family members, and
- Psychosocial care.

The most important preventive measure is the early identification of at-risk feet and regular self-monitoring as well as professional monitoring to prevent acute events from occurring despite the loss of protective warning mechanisms as part of neuropathy (loss of protective sensations, LOPS). The individual risk profile of the patient must be taken into account during the examination intervals (see ► **Tab. 1**). The at-risk foot is not defined only by an ulcer or pre-ulcerative foot lesion. There are risk constellations that can be identified before an active event and prevented (at best) by implementing proper measures. Mechanical factors play a major role in the development of diabetic foot ulcers. Injuries occur as a result of repeated exposure to increased pressure and shear forces during walking. The most important trigger of lesions is unsuitable or unworn footwear! Therapy and/or prevention also include foot surgery, such as the extension of the Achilles tendon in the case of functionally-increased forefoot pressure or cutting of tendons as with hammer/claw toes (see 1.5.4 "Pressure relief")

### Organization of care

The care provided by a multidisciplinary team of general practitioners, diabetologists, vascular specialists (vascular surgeons, angiologists, interventional radiologists), surgeons, orthopedists, diabetes nurses, shoemakers and podiatrists (shared care) significantly reduces the incidence of amputations. In accordance with the recommendations of the International Working Group on the Diabetic Foot (IWGDF), early referral of the patient to an interdisciplinary and multi-professional foot treatment center is therefore required (<https://iwgdfguidelines.org/german-translation/>).

For Germany, the DDG Foot Working Group has developed comprehensive and now widely-recognized structures that meet the requirements of shared care and, at the same time, reflect effective quality management.

► **Tab. 7** Shoe care and risk classifications for diabetic foot syndrome and associated neuro-angio-arthropathies. Data according to [12].

	Risk group	Explanation	Standard care
0	Diabetes mellitus without PNP/PAOD	Information and advice	Ready-made shoes suitable for feet
I	As in 0, with foot deformation	Higher risk of later occurrence of PNP/PAOD	Orthopedic shoe care because of orthopedic indication
II	DM with loss of sensitivity due to PNP/PAOD	Loss of sensitivity proven due to missing recognition of the Semmes Weinstein monofilament	Diabetes protective shoe with removable soft padded sole, if necessary with orthopedic shoe fitting; higher care with DAF or orthopedic custom-made shoes for foot proportions that do not match ready-made shoes/foot deformity leading to local pressure increase/unsuccessful adequate preliminary care/orthopedic indications
III	Condition after plantar ulcer	Significantly increased risk of ulcer recurrence compared to grade II	Protective diabetic shoe usually with diabetes-adapted insoles, if necessary with orthopedic shoe fitting; higher care with orthopedic custom-made shoes for foot proportions that do not match ready-made shoes/unsuccessful adequate preliminary care/orthopedic indications
IV	As in II with deformities or disproportions	Not possible to provide care with ready-made shoes	Orthopedic custom-made shoes for DAF
V	DNOAP (Levin III)	Orthoses usually for DNOAP type IV-V (Sanders) or in case of a strong perpendicular deviation	Cross-bone orthopedic custom-made shoes for DAF, inner shoes, orthoses
VI	As in II with foot section amputation	At least transmetatarsal amputation, internal amputation also possible	Care as in IV plus prostheses
VII	Acute lesion/florid DNOAP	Always as temporary care	Relief shoes, bandage shoes, interim shoes, orthoses, TCC if necessary with DAF and orthopedic fittings

PNP = polyneuropathy; PAOD = peripheral arterial occlusive disease; DNOAP = diabetic neuropathic osteo-arthropathy; TCC = total contact cast; DAF = diabetes adapted footbed

## Footwear

Most patients require adequate footwear for both street and home use. The principles of shoe care for patients with diabetes mellitus are based more on sufficient space and suitable insoles with even pressure distribution than on biomechanical, orthopedic correc-

tion of deformities. The shoes and especially the insoles should be checked frequently for wear and, if necessary, replaced. The materials used to relieve pressure lose their restoring force over time. Checking pressure-relieving footbeds for their effectiveness by means of pressure measurement in the shoe leads to better prevention against the recurrence of ulcers. A practice-oriented classification of the stage-appropriate prescription of therapeutic footwear is available at [www.ag-fuss-ddg.de](http://www.ag-fuss-ddg.de) (see ► **Tab. 7**). An up-to-date overview of the existing evidence as well as concrete instructions for the production of orthopedic footwear for people with diabetes was recently published by the working group led by Siccio Bus (Netherlands) [14].

### MINIMAL CRITERIA FOR THE SHOE CARE FOR DFS

- Enough space for the toes in length and height,
- Sufficient width,
- No pressing seams,
- Soft material over pressure-prone foot areas which move,
- No toe cap with an effect on the foot,
- Removable ready-made padded sole with pressure peak reduction in the ball area by 30% and
- Possibility of orthopedic shoe fittings.

A medical approval of the prescribed aid together with the patient is always necessary. The instruction of the aid is carried out by the supplier of the aid.

When handing over the aid to the patient, the function must be checked for statics and dynamics and, if necessary, optimized by orthopedic fittings.

- Are the prescribed components included?
- Is the proper fit ensured?
- Is it safe for standing, walking and surefootedness?
- Is the proper function ensured in terms of protecting the foot and compensating for functional limitations?
- Were the criteria for shoe care for DFS met?

The term 'diabetic protective shoe' shall be used in the same sense as 'diabetic special shoe', 'orthopedic shoe', 'ready-made therapeutic shoe' or 'semi-orthopedic shoe'.

The verifiable documentation of targeted local pressure relief through a diabetes-adapted footbed (DAF) is only possible under dynamic conditions with the help of pedobarographic measurement soles. For the documentation of zones of increased pressure due to functional deformities, dynamic pedography is superior to static methods (imprint).

For the correction or functional compensation of a higher degree of foot deformity by means of custom-made shoes, an individual special fitting must be produced manually according to a plaster cast or a comparable technique. The current state of automation technology allows custom-made production only for slightly deformed feet.

In individual cases, a deviation from the above-mentioned arrangement is possible with more complex or simple care as per the medical indication.



The criteria for a higher level of care must be verifiably documented and the corresponding diagnoses must be included on the medical prescription.

#### CRITERIA FOR A HIGHER LEVEL OF CARE

- Contralateral major amputation
- Arthropathy hip/knee/OSG or joint implant with functional impairment/contracture
- Amputation of the big toe/resection metatarsal bones
- Motor function restriction/paresis of one or both legs
- Higher degree of uncertainty when walking/standing
- Extreme obesity (BMI = 35 kg/m<sup>2</sup>)
- Renal failure requiring dialysis
- Occupation with mostly standing or walking
- Significant visual impairment

In the case of an acute lesion (ulcer or even fluoride DNOAP), total relief with an Allgöwer walking apparatus or Thomas splint is only necessary in exceptional cases. In the case of an ulcer, pressure relief and pressure redistribution are of primary importance whereas for DNOAP, importance is placed on eliminating ankle movements.

For follow-up, outpatient examinations are required at least every 3 months from group III onwards.

#### ADDRESSES ON THE INTERNET

[www.deutsche-diabetes-gesellschaft.de](http://www.deutsche-diabetes-gesellschaft.de)

- Current version of the evidence-based guidelines: [www.ag-fuss-ddg.de](http://www.ag-fuss-ddg.de)
- International Working Group on the Diabetic Foot Guidelines 2019, original and German translation
- Examination form of the Foot Working Group
- Facilities for the treatment of diabetic foot syndrome
- Links to other sites that provide information about the diabetic foot syndrome
- “Oppenheimer Erklärung” (statement)
- [www.diabetes-cme.de](http://www.diabetes-cme.de)
- Continuing education on diabetes mellitus in accordance with guidelines. The knowledge presented here is compiled on the basis of the evidence-based diabetes guidelines of the German Diabetes Society (DDG).
- [www.diabetes-deutschland.de](http://www.diabetes-deutschland.de)
- Information system on diabetes mellitus
- [www.rki.de](http://www.rki.de)
- Website of the Robert Koch Institute, including recommendations for targeted antibiotic therapy
- [www.n-v-l.de](http://www.n-v-l.de)
- National Healthcare Guideline on Type 2 Diabetes
- [www.AWMF.de](http://www.AWMF.de)
- S3 Guideline PAOD of the German Society of Angiology

## Conflicts of interest

S. Morbach has been active in the National Advisory Board DFU of URGO GmbH for the past 3 years and has received corresponding fees. In the past 3 years, he has received research funding in the sense of monetary benefits (equipment and materials) from the company Reapplix AS. He is a visiting researcher at the Institute for Health Services Research and Health Economics, Centre for Health and Society, Medical Faculty, Heinrich-Heine-University Düsseldorf.

R. Lobmann has received research funding (personally or at his personal disposal) either directly or in the form of monetary benefits (personnel, equipment, etc.): Urgo (E2-Sub-study). As a speaker he received a fee or as a passive participant he received a reimbursement of costs (travel or accommodation costs, paid participation fees): Honorary speaker: Böhringer Ingelheim, Daiichi-Sankyo, GWT-TUD GmbH, Lilly, Novo Nordisk, SanofiAventis, URGO, Wörwag Pharma. Reimbursement of costs: Abbott, Urgo, Wörwag. He has been a paid consultant/internal training consultant or similar for: Abbott, URGO, Wörwag Pharma. Membership and position in scientific societies/professional associations and possibly other associations relevant to this training measure: Member of the board of the ADBW, spokesman of the regional societies of the DDG, member of the Diabetes Advisory Board of the State Government of Baden Württemberg, delegate for D-Foot International, member of the board of the German Diabetes Society (DDG; 2016–2020), spokesman of the DDG Working Group on the Diabetic Foot (2010–2020).

A. Risse has been active within the last 3 years in advisory boards of URGO GmbH and Neubourg Skin Care and has received corresponding fees. For lectures and training activities he received fees from the companies URGO GmbH and Paul Hartmann AG. He is chairman of the Pharmacists in Diabetology Commission.

M. Eckhard has worked for the following companies within the last 3 years and has received research funding in the sense of monetary benefits (equipment and materials) from: Reapplix AS. As a speaker, consultant or author, he has received fees or expense allowances from the following companies or institutes within the last 3 years: Astra-Zeneca, Boehringer-Ingelheim, Diabetologen Hessen e.G., Landesärztekammer Hessen (Hesse State Medical Council), Lilly Deutschland, Novo Nordisk, Schwarzkopf Institute, Springer-Verlag. Accompanying offices: Chairman of the Hessian Diabetes Society Chairman of the Hessian Diabetes Society e.V. (HDG, Regional Society of DDG), spokesman of the Diabetic Foot Working Group of the DDG (since 2020), Professional status: Medical Director of the University Diabetes Center at the University Hospital Giessen and Marburg GmbH (UKGM, Giessen location), Chief Physician of the GZW Diabetes Clinic Bad Nauheim.

H. Reike discloses that the Mariannen-Hospital has received support for events organized by him from the companies Novo Nordisk Deutschland, Lilly Deutschland, Beurer, Emmerich.

M. Spraul has worked for the following companies within the last 3 years and has received corresponding fees: Lilly Deutschland (lectures and consulting), Novo Nordisk (lectures and consulting), Neubourg Skin Care (lectures and consulting). M. Spraul discloses that the Mathias-Spital has received support from the companies Novo Nordisk Deutschland and Neubourg Skin Care for events organized by him.

## Conflicts of Interest

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G. Rümenapf and E. Müller have no conflicts of interest.

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