Original article

Wound bed preparation 2024: Delphi consensus on foot ulcer management in resource-limited settings

ABSTRACT

Background Chronic wound management in low-resource settings deserves special attention. Rural or underresourced settings (ie, those with limited basic needs/healthcare supplies and inconsistent availability of interprofessional team members) may not be able to apply or duplicate best practices from urban or abundantly resourced settings.

Objective The authors linked world expertise to develop a practical and scientifically sound application of the wound bed preparation model for communities without ideal resources.

Methods A group of 41 wound experts from 15 countries reached a consensus on wound bed preparation in resource-limited settings.

Results Each statement of 10 key concepts (32 substatements) reached more than 88% consensus.

Conclusions The consensus statements and rationales can guide clinical practice and research for practitioners in low-resource settings. These concepts should prompt ongoing innovation to improve patient outcomes and healthcare system efficiency for all persons with foot ulcers, especially persons with diabetes.

Keywords delphi consensus, low- and middle-income countries, diabetes, foot ulcer, innovation, low-resource settings, rural, wound bed preparation

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GENERAL PURPOSE

To review a practical and scientifically sound application of the wound bed preparation model for communities without ideal resources.

TARGET AUDIENCE

This continuing education activity is intended for physicians, physician assistants, nurse practitioners, and nurses with an interest in skin and wound care.

LEARNING OBJECTIVES/OUTCOMES

After participating in this educational activity, the participant will:

1. Summarise issues related to wound assessment.

2. Identify a class of drugs for the treatment of type II diabetes mellitus that has been shown to improve glycemia, nephroprotection, and cardiovascular outcomes.

3. Synthesise strategies for wound management, including treatment in resource-limited settings.

4. Specify the target time for edge advancement in chronic, healable wounds.

INTRODUCTION

A framework for wound bed preparation (WBP) was introduced in 2000 to emphasise treating the whole person as a foundation of optimal local wound care.[1] As this has evolved into an international framework, it became clear that not all wounds are healable. These concepts of maintenance and nonhealable wounds led to revisions of local wound care principles and WBP expansion. The importance of integrated coordinated care with nurses, doctors, and allied healthcare professionals working together to optimise patient care outcomes and healthcare system utilisation was paramount in further WBP developments.

This article focuses on applying the WBP framework to manage foot-related wounds, particularly in persons with diabetes (PWDs), leprosy-related neuropathic foot ulcers, and other complications that include neuropathy and vascular disease. Several parameters are critical to PWDs, including poor glycemic control, BP changes, high cholesterol, inadequate plantar pressure redistribution, infections, and lack of exercise. The effects of smoking are also particularly detrimental to saving limbs and lives of PWDs.

Critical for this article is a set definition for resource-restricted settings, including low resource availability; lacking or restricted funding; remote, isolated, or rural settings; and Indigenous populations. These terms all relate to healthcare settings that may have challenges accessing supplies, equipment, specialists, and advanced wound care competencies and skills. Low-resource settings can be present anywhere in the world and are not limited to lower-income or developing countries.

The Delphi process underpinning this work expanded and developed the WBP framework in its current format. Forty-one authors drawn from 15 countries took part in the Delphi process, which occurred over two rounds using a four-part Likert-type scale (1, strongly agree; 2, agree; 3, disagree; 4, strongly disagree). The first round consisted of 29 statements. Although all statements exceeded the desired 80% consensus level, there were 299 comments considered by the lead group of authors. A professional editor was employed to improve the comprehension and grammatical accuracy of the statements before a Delphi round 2 was deployed with 32 constructed statements. All statements exceeded 88% consensus level.

In round 2, 14 statements achieved 100% consensus. One statement stood out and was rated as "strongly agree" by all Delphi panel members: *10C. Establish timely and effective communication that includes the patient and all interprofessional wound care team members for improved healthcare system wound outcomes*. In parallel, each of the international wound experts worked in groups to develop the manuscript content. Refer to Supplemental Table 1 (http://links.lww.com/NSW/A176) for the consensus statements.

The consensus aimed to set a scientifically based minimal standard of care that could be optimised for available resources. Refer to Table 1 for the 10 key steps and 32 substatements for wounds in limited-resource environments. This consensus process updated the framework for WBP to be applicable regardless of resource availability. In addition, it also includes the concepts of healing trajectories and healthcare system change for the first time (Figure 1).

The remainder of this report will highlight the 10 consensus statements and discuss the rationale for each statement.

STATEMENT 1: TREATMENT OF THE CAUSE

1A. Assess for adequate arterial perfusion to ensure proper wound healing (palpable foot pulse[s] and/or multiphasic arterial foot artery sounds with an 8-MHz Doppler)

To determine lower-limb blood flow, find a palpable foot pulse(s) as a vital first action. Start with the dorsalis pedis and/

or the posterior tibial pulses. If an 8-MHz handheld Doppler is available, confirm multiphasic flow patterns (biphasic/triphasic). Refer to vascular specialists when a monophasic or absent Doppler sound is observed or foot pulses are not palpable. Other signs of inadequate arterial perfusion are lower limb pain at rest and ischemic limb changes (cold extremity with dependent rubor that blanches on elevation).

Persons with diabetes are susceptible to microvascular issues (peripheral neuropathy, Charcot foot changes) and macrovascular complications including peripheral arterial disease (PAD). These conditions contribute to calluses, foot ulcers, and mixed tissue loss. Because up to 50% of susceptible populations experience both diabetes and PAD,[2] timely identification of PAD is critical (using physical examination and vascular tests) because it is a major risk factor for poor ulcer healing and amputation. If detected, immediate revascularisation (angioplasty or vascular bypass) is vital to restore proper arterial flow to the foot. Additional assessment may include capillary refill time, a Buerger blanching test (pale on elevation, bright red rubor on dependency), and claudication with walking.

Vascular examination. In cases of arterial insufficiency, the extremity is often cool to the touch because of insufficient nutrient and oxygen supply (Table 2). Severe cases may manifest tissue necrosis presenting as ulcers, macerated toe webs (often with secondary infection), fissures, or gangrene. Other severe case indicators include pallor upon leg elevation, exercise-induced claudication that resolves with rest, dependent cyanosis or rubor, and muscle atrophy. Notably, lower extremity edema is more indicative of venous rather than arterial issues. Arterial lesions are generally punched out, with a deep base that often contains tendons, whereas venous ulcers show irregular border morphology with a shallow granulation tissue base.[3]

Ankle-brachial pressure index (ABPI) examination. The ABPI measures the ratio of ankle systolic BP divided by the brachial systolic BP using an 8-MHz Doppler. The procedure involves using a BP cuff and recording systolic BP when arterial sounds reappear after cuff inflation. However, factors such as edema, inflammation, and arterial calcification can affect its accuracy. If an 8-MHz Doppler cannot be afforded/obtained, early referral to a tertiary assessment center becomes the priority in cases where the absent foot pulses are present. In certain healthcare settings, an ABPI is still required as vital quantification assessment before beginning any lower limb intervention.

Audible handheld Doppler (AHHD) examination. An AHHD can easily be added as an additional parameter in certain settings, should providers choose a simpler and faster test (not influenced by calcification, no need to squeeze a painful calf, and no need to be recumbent for 20 minutes). The AHHD assessment also can provide accurate results in case of large toe amputation and be recorded as an MP3 or MP4 file and transferred for remote verification of the signal interpretation.

Healthcare professionals should apply gel on the appropriate foot pulse sites with an 8-MHz Doppler probe positioned at a 45° angle to the skin on the dorsalis pedis, posterior tibial, and peroneal arteries. The acquired Doppler signals/waveforms can then be analysed (either by audible sound or visual tracings):

Figure 1. Wound bed preparation 2024. ©WoundPedia 2023

Table 1. Wound bed preparation for wounds below the knee in environments with limited resource availability

No.	Statement	Substatements
1	Treatment of the cause	Assess for adequate arterial perfusion to ensure proper wound healing (palpable foot pulse[s] and/or multiphasic arterial foot artery sounds with an 8-MHz Doppler). Identify all underlying causes. Triage the most important causes/comorbidities to treat immediately and design targeted intervention(s) within locally available support systems/resources. Prioritise redistribution of pressure for foot wound(s) and choose appropriate compression for leg/foot edema based on arterial perfusion.
2	Patient-centered concerns	Assess pain using a pain scale with a targeted plan for nociceptive and/or neuropathic pain management. Identify activities of daily living that may affect healing outcomes. Assess patients for (harmful) lifestyle habits that may impact wound healing (eg, smoking, alcohol, and other substances). Empower patients using sustainable educational interventions that include their support system. When possible, use the patient's primary language and consider their cultural background, religion, accepted behaviors, taboos, and beliefs.
3	Wound healability	Determine if adequate blood supply is present for wound healing and that appropriate treatment is available to address the underlying cause(s). This is a healable wound. Adjust practice if adequate blood supply is present for wound healing but the patient cannot adhere to the plan of care and/or the healthcare system does not have the required resources. This is a maintenance wound. Determine alternative wound treatment(s) if blood supply is inadequate and/or the underlying cause cannot be corrected. This is a nonhealable wound.
4	Local wound care: examine, measure, and monitor	Document wound progress from baseline to establish measurable healing trajectories (paper-based and/or photoimaging, if available). Cleanse wounds with tepid (preboiled) potable water, saline, or low-toxicity antiseptic agents. Consider soaks, compresses, and irrigation, where appropriate. Reassess and document wounds regularly at appropriate intervals over time with available resources. Document and maintain confidentiality of the data.
5	Local wound care: debridement	Healable wounds/cause corrected: consider active sharp surgical debridement to bleeding tissue with adequate pain control only if it is within your scope of practice. This is undertaken with guidance from advanced wound care expertise only. If not available, consider conservative (sharp) debridement. Maintenance wounds/nonhealable wounds: consider conservative (sharp) debridement with adequate pain control only if it is within your scope of practice. Only remove loose hanging slough/debris when indicated and without causing any bleeding. Determine if alternative debridement modalities for healable wounds are available (eg, autolytic, mechanical, enzymatic, and maggot/biological options).
6	Local wound bed: infection and inflammation	Treat local/superficial wound infection (three or more NERDS criteria) with topical antimicrobials. Manage deep and surrounding wound infection (three or more STONEES criteria) with systemic antimicrobials and concurrent topical antiseptics. Consider anti-inflammatory agents in wounds with persistent ongoing inflammation (topical dressings or systemic medication).
7	Local wound bed: moisture management	Maintain moisture balance in healable wounds with hydrogels, films, hydrocolloids, hydrofibers, alginates, and foams. Institute moisture reduction with fluid-lock mechanisms in healable wounds using superabsorbents to wick moisture away from the surface (diaper technology). Determine if wound packing is needed for healable wounds. It could be wet (donate moisture) or dry (absorb moisture). Establish a targeted moisture reduction protocol in maintenance and nonhealable wounds to reduce bacterial proliferation.

No.	Statement	Substatements
8	Local wound bed: edge advancement	Consider that healable wounds should be at least 20%-40% smaller by week 4 to heal by week 12. If factors are present that affect healing time (poor glycemic control, for example), additional healing time may be required. Allocate additional time to healing beyond 12 weeks in healable wounds if there are limited available resources and continue with consistent care. Prioritise referral to specialist centers (when available) for diagnostic testing and/or a skin biopsy, especially when faced with severe resource restrictions.
9	Local wound bed: edge support	Consider locally constructed active modalities according to the required mechanism of action and the specific indications for initiating an adjunctive therapy to support wound healing. Decide on adjunctive therapies through an interprofessional team approach and include a prior risk-to-benefit analysis.
10	Healthcare system change	Facilitate evidence-informed, culturally competent, and equitable care for all patients. Improve provider skills for wound management competency to enhance patient outcomes. Establish timely and effective communication that includes the patient and all interprofessional wound care team members for improved healthcare system wound outcomes.

Abbreviations: NERDS, for superficial wound infection: nonhealing, exudate, red friable granulation tissue, debris, smell; STONEES, for deep and surrounding wound infection: size increased, 3 °F temperature warmer, os (probe to bone), new areas of breakdown, erythema >2 cm, exudate, smell.

Table 2. Vascular supply needed for tissue healing

Test	Measurement	Comment
Palpable pulse[a]	>80 mm Hg	Average threshold for palpating a foot pulse
ABPI	>0.5 and <1.4	Range of ABPI for large vessels that are not calcified
AHHD	biphasic, triphasic AHHD ABPI >0.9	AHHD level equivalent to an ABPI ≥0.9 (not influenced by calcification)
Toe pressure	>30–55 mm Hg	Large toe arteries do not develop circumferential calcification, making this a reliable test

Abbreviations: ABPI, ankle-brachial pressure index; AHHD, audible handheld Doppler.

[a]If there is no palpable pulse, a monophasic audible handheld Doppler signal, or an ABPI <0.5, order or refer for a lower-leg duplex segmental arterial Doppler and toe pressures.

A comprehensive tutorial on the AHHD procedure is available online at https://journals.lww.com/aswcjournal/Pages/videogallery.aspx?videoId=20. Optimise signal quality with careful repositioning of the probe to obtain the loudest or most multiphasic signal.

A monophasic or absent waveform warrants a comprehensive vascular assessment, including a Duplex segmental lower leg arterial Doppler in the vascular laboratory. A multiphasic waveform typically indicates the absence of peripheral vascular disease.[4] In PWDs, interpret the ABPI ratio with caution (due to arteriosclerosis or arterial calcification); AHHD multiphasic findings are a preferable choice to confirm adequate blood supply for wound healing. A multiphasic waveform (biphasic, triphasic) suggests an AHHD value equivalent to a normal ABPI ≥0.9.

Although AHHD is effective in excluding arterial disease, it may not identify existing segmental perfusion deficits—islands of ischemia or angiosome defects.[5] Therefore, physical examination of the foot and lower limb is vital for a conclusive diagnosis. Healthcare professionals can record AHHD signals and transmit them to specialists, facilitating either synchronous or asynchronous assessments remotely. Synchronous assessments enable real-time patient involvement and prompt decision-making.

Chronic venous insufficiency. Chronic venous insufficiency may coexist in PWDs and those with foot ulcers. It mainly affects the lower limbs and impairs the return of deoxygenated blood to the heart and lungs. This condition often arises from venous valve dysfunction that can be triggered by factors including pregnancy or weight gain. Symptoms commonly include varicose veins, edema, skin discoloration from hemosiderin, lipodermatosclerosis, and venous ulcers.[6] These ulcers can be any size (from small to circumferential) and form quickly over areas of venous pooling, usually on the medial aspects of the lower limbs.

The cornerstone of treatment for venous ulcers is compression therapy. This compensates for valve dysfunction by enhancing the peristaltic action of the calf muscle pump. Additional measures include leg elevation and walking. Venous ablative procedures may be considered when ulcers are attributed to superficial veins. Untreated venous edema can delay foot ulcer healing.[7]

For the medical optimisation of PAD, key strategies include optimal BP control, initiating cholesterol medication, and, often, starting statin therapy. Recent studies also recommend treating patients with PAD and concurrent coronary artery disease or carotid disease using a combination of low-dose aspirin (91-100 mg PO daily) and low-dose rivaroxaban (2.5 mg PO BID).[8] Additional modifiable factors are smoking cessation and walking or exercise programs. For patients with a foot ulcer (especially in PWDs), appropriate plantar pressure redistribution or offloading is essential.

1B. Identify all underlying causes

Foot complications are of great concern to PWDs and represent a significant burden of disease to healthcare systems. A holistic approach is represented by the mnemonic AIM (assessment, identification, management) and focuses on treating or mitigating the underlying cause of diabetic foot issues, especially neuropathy. The application of a focused assessment approach as a baseline standard of care (VIPS: vascular, infection, pressure, surgical debridement) is crucial in preventing severe complications, including foot ulcerations, lower limb amputations, and an increased incidence of early/preventable death. Some critical foot-related elements in resource-challenged settings include late presentations to formal care, delayed diagnosis,[9] barefoot walking, neglected wounds, and the absence of preventive foot care. A hospital-based observational analysis conducted in Ethiopia identified several factors contributing to diabetic foot complications;[10] these included high humidity, foot deformity, neuropathy, unidentified active ulcers, inadequate or ill-fitting footwear, poor foot hygiene (eg, foot and toenail fungus), and lack of foot care awareness. A systematic review on plantar ulcers among patients with leprosy (n = 7 studies) identified the following risk factors for developing ulcers: inability to feel a 10 g monofilament on sensory testing, severe foot deformities or hyperpronation, lower education, and unemployment.[11] Addressing these challenges in any resource-challenged environment requires a multipronged approach that may include patient and healthcare professional education, early detection, access to care, footwear programs, and community engagement.

Regular and thorough foot assessments include detecting neuropathy (loss of protective sensation), vascular issues (poor or absent lower limb blood circulation), signs of infection, areas of high pressure (callus formation), and friction (blisters, often with hemorrhagic components) to facilitate timely interventions. The simplified 60-second screening tool may be a valuable means to quickly assess, stratify, and follow up patients based on their risk levels without significant cost.[12] Patients with a history of ulceration, amputation, peripheral vascular surgery, or Charcot neuroarthropathy are at the highest risk for skin breakdown and should receive additional attention to prevent ulceration and further complications.

To detect infection, the NERDS (superficial wound infection: nonhealing, exudate, red friable granulation tissue, debris, smell) or STONEES (deep and surrounding wound infection: size increased, 3 °F temperature warmer, os [probe to bone], new areas of breakdown, erythema >2, exudate, smell) criteria along with using noncontact infrared thermometry can be helpful.[13] Elevated temperatures of 3 °F compared with the opposite limb may signal inflammation and a foot at a higher risk of ulceration.[13] A comparative change of 1.67 °C is difficult to measure clinically. This same finding in a person with a lower leg or foot ulcer is eight times more likely to signify deep and surrounding infection when accompanied by two or more additional STONEES criteria.[13]

Patients with neuropathy without an ulcer and presenting with a hot swollen foot could have acute Charcot neuroarthropathy. Infrared thermometry is a valuable assessment tool in these cases: acute Charcot feet may be 8 to 15 °F warmer than the mirror image on the opposite foot. These patients require a comprehensive medical history, physical examination, and radiographic images to facilitate early detection. Further actions include the application of a total contact cast for stabilisation and complete plantar pressure offloading with a wheelchair to prevent further bone deterioration and prevent lower limb amputation (Table 3).

Callus formation in PWDs is positively correlated with pressure and shear stress. In individuals with diabetic neuropathy, various factors including foot deformities, limited joint mobility, repetitive stress during walking, and poorly fitting shoes can increase the risk of callus formation.[14] Moreover, the presence of calluses can pose a significant risk because repetitive trauma may lead to subcutaneous hemorrhage and eventually progress to ulceration. Provide tailor-made pressure redistribution devices (soft insoles, cobbler interventions to adapt shoes, and reduced barefoot walking) to prevent subsequent callous-to-ulcer progression.

Different etiologic causes may lead to foot ulcers in PWDs: *neuropathic* because of peripheral neuropathy, *ischemic* associated with PAD, or a combination of both—*neuroischemic* foot complications. The presence of diabetic neuropathy is established from medical history; physical examination (5.07/10 g monofilament test); altered sensation distributed symmetrically in both limbs (stocking and glove distribution); and burning, stinging, shooting, or stabbing pain.

1C. Triage the most important causes/comorbidities to treat immediately and design targeted intervention(s) within locally available support systems/resources

A diabetic foot ulcer (DFU) occurs in 25% to 34% of PWDs and is one of the most feared complications, potentially leading to lower limb amputation, severe disability, and reduced life expectancy.[15] Multifactorial in origin, diabetes-related peripheral neuropathy and PAD leave feet highly vulnerable to traumatic injury. Access to timely diagnosis and intervention are determinant factors in effective management and limb preservation.

Chronic hyperglycemia measured by elevated hemoglobin A_{1c} (HbA_{1c}) is a major risk factor for sensory, motor, and autonomic neuropathy. Both PAD and dry skin increase foot vulnerability

to infection and delayed healing, all contributing to poor outcomes. Chronic kidney disease adds to the risk.[16] Recent studies of continuous glucose monitoring report that high glucose variability (reduced time to target range levels) may additionally contribute to long-term complications.[17]

Up to 50% of PWDs will develop neuropathy with no known cure. Management includes proper daily foot inspections for evidence of trauma or infection, foot care, and effective glucose control.[18] In addition to neuropathy, PAD contributes equally to DFUs; PAD is largely asymptomatic and may remain underdiagnosed and untreated for a prolonged period. Individuals with diabetes have more than a twofold increased prevalence of PAD compared with those without.[19] A systematic review of community-based studies for global prevalence and risk factors for PAD ranked diabetes highest next to smoking.[20]

The European Society of Hypertension recommends providers and patients target a systolic BP less than 130 mm Hg and diastolic BP less than 80 mm Hg. In PWDs, systolic BP should not fall less than 120 mm Hg to prevent reduced blood flow to vital organs and lower limbs.[21] Although diuretics, calcium-channel blockers, angiotensin-converting enzyme inhibitors, angiotensin receptor blockers, and β-blockers can all be used, angiotensin-converting enzyme inhibitors and angiotensin receptor blockers reduce cardiovascular events.[22,23] Recently, SGLT2 inhibitors have shown excellent results in improving glycemia, nephroprotection, and cardiovascular outcomes.[24] In addition, DFU incidence is reduced by early detection of PAD with lifestyle modifications.[17]

The complexity of managing a DFU requires an interprofessional team approach to identify biological, social, geographic, and cultural determinants of health. In Denmark, PWDs are registered by region with access to specialised clinics with interprofessional wound care teams. Lower limb amputation rates have declined significantly due to improved diabetes care, regular foot inspection, better self-care, and timely treatment.[25] In more geographically dispersed diverse populations (eg, Ontario, Canada), significant disparities in amputation rates exist, highest in rural regions where timely prevention such as revascularisation surgery and foot care specialists are underserviced or absent.

The most vulnerable persons for diabetic foot-related amputations in Canada are Indigenous people, immigrants, and persons living in rural and northern regions.[26] The Indigenous Diabetes Health Circle provides a culturally sensitive approach to local Ontario First Nations communities with education and knowledge about diabetes, wellness, and self-management. Its holistic foot care program supports a continuum of services that connects community members to

Table 3. Offloading interventions for a plantar diabetic/neuropathic foot wound[28]

Line	Device	Notes
First	• Total contact cast (TCC) • Removable cast walker (RCW) (knee-high) made irremovable	• TCC requires specialised training • Choice dependent on resources available, technical skills, patient preferences, and extent of foot deformity • Refer to specialty wound clinic • TCC may impact employment (in driving, standing, and moving objects around) and requires time-off period (4-6 wk)
Second	• RCW (knee-high) • RCW (ankle-high) • Surgical shoe (eg, offloading boots or special shoes)	• First line contraindicated, not tolerated, or unavailable • Use with a customised insole • Encourage patient to always wear device when weight bearing • Consider adding a foot-device interface to device +/– felted foam
Third	• Standard therapeutic shoe with customised insole • Felted foam offloading padding added to existing footwear with customised insole	• First and second line contraindicated, not tolerated, or unavailable • Encourage patient to always wear device when weight bearing
Resource-limited settings	• Use local resources for custom offloading solutions	• All other options contraindicated, not tolerated, or unavailable • Use digital technology for guidance if available • Prioritise safety and regular monitoring • Foster creative and collaborative local solutions tailored to patient needs • Establish a feedback system for continuous improvement • Involve patients in decision-making for better comfort and adherence to always wear device when weight bearing • Consider patient preference when combining two offloading modalities

Indigenous agency partners and local healthcare professionals and is proven to reduce DFU incidence and prevent amputations.[27]

1D. Prioritise redistribution of pressure for foot wound(s) and choose appropriate compression for leg/foot edema based on arterial perfusion

The criterion standard for plantar pressure redistribution devices is the total contact cast or the removable cast walker made irremovable.[28] Even in healthcare systems in which these offloading modalities are readily available, less than 10% of eligible patients are fitted for and adherent to the use of these devices.[29]

Offloading is paramount to healing foot ulcers (Table 3). The aim is to select the best device for the patient incorporating patient-centered concerns, the goals of care, and best practice evidence. Consider creative solutions to repurpose local materials such as soft felted inserts for offloading in resource-limited settings. It is important to establish an early surveillance program between the patient and healthcare professional to monitor and ensure the desired offloading outcomes. Healthcare professionals need to evaluate the effectiveness of the devices and continually make modifications as needed through established follow-up. In regions lacking specialised practitioners, empowering healthcare workers with competencies in basic offloading can bridge this gap.

STATEMENT 2: PATIENT-CENTERED CONCERNS

2A. Assess pain using a pain scale with a targeted plan for nociceptive and/or neuropathic pain management

The perception of pain involves a stimulus that may be physical or chemical. There are two main types of pain: nociceptive and neuropathic (Table 4). Wound-related pain is an important component of patient-centered concerns that is often undervalued by healthcare professionals. By the late 1990s, wound pain was a focus for healthcare professionals with the launch of a pivotal position document focused on wound pain.[30] The document recognised and focused on the distress of chronic wound pain and its influence on patients' health-related quality of life. The management of wound pain was then integrated into the WBP framework.[1,31]

Pain can play a significant role in the total management of persons with wounds and their ultimate healing success.[32] Pain signals associated with injury play an important function in patient wellness and as such must be acknowledged through adequate assessment and management. For example, pain or any change in pain is a key predictor of wound infection and one of the four cardinal signs of inflammation.[1] Unresolved pain is often associated with delayed wound closure.

Assessment. A pain history is essential to wound pain management.[32] Assessment must include the nature, onset, duration, and exacerbating and relieving factors. This will help determine the cause of the pain and direct its management. Pain intensity can be reliably measured using validated pain scales. A verbally administered 0- to 10-point numerical rating scale is a good first choice for measuring pain numerical intensity. Most patients can function with a pain level of 3 to 4 out of 10.[33]

Patients with persistent pain should be reassessed regularly for improvement, deterioration, and adherence to medication regimens. The use of a pain diary with entries regarding pain intensity, medications used, mood, and response to treatment may be a good management strategy. For individuals with communication limitations, the pain scale should incorporate pictures for easy recognition.

Management. The management of wound pain can be integrated into the WBP framework: treat the cause and address local wound factors and patient-centered concerns.[3] Treating the cause should determine the correct diagnosis and initiate treatment of the wound pain. Patient-centered concerns must focus on what the patient sees as the primary reasons and resolutions for the pain. Patient anticipatory pain and suffering can be just as disruptive to quality of life as the actual experience of pain.

Multiple pain management strategies exist and are not always pharmaceutical (Table 5). Consider total patient management, including all aspects of WBP, in choosing a management strategy. Remember: pain is what the patient says it is.[34]

Assessment and management given limited resources. In regions with limited resources, assessment remains possible because it requires no costly tools. Most pain scales are freely available despite some initial cost relative to education and training of practitioners.[31] Treatment options for pain

Table 4. Pain types and responses[30]

Pain Type	Features
Nociceptive	• Inflammatory response to tissue damage with an identified trigger or stimulus • Usually present • Relatively acute onset • Resolves when the tissue damage stops and the inflammation subsides
Neuropathic	• Independent of acute stimuli or triggers • Often described as tingling or stinging and when more severe, as stabbing or shooting • Local area may be warm or have sudden unpredictable "jumping" or electric shock-like sensations • With persistent tissue injury and inflammation, the peripheral nerves become sensitised • Increased sensitivity leads to allodynia and hyperalgesia • Secondary increase in surrounding uninjured skin sensitivity to any stimulation (eg, slightly stroking the skin)

in resource-restricted environments may be more practical if driven with nonpharmacologic methods (Table 5). Some of these options may also be more socially acceptable or already practiced culturally (eg, meditation, plant-based treatments) and particularly applicable in nociceptive pain management. Implementing such strategies can then preserve pharmaceutical management for those with pain that cannot be managed by nonpharmacologic means (eg, neuropathic pain).[35]

2B. Identify activities of daily living that may affect healing outcomes

2C. Assess patients for (harmful) lifestyle habits that may impact wound healing (eg, smoking, alcohol, and other substances)

2D. Empower patients using sustainable educational interventions that include their support system. When possible, use the patient's primary language and consider their cultural background, religion, accepted behaviors, taboos, and beliefs

In resource-limited environments, patient-centered concerns and barriers to clinical outcomes are crucial for providers to understand and address within the context of cultural, spiritual, and religious beliefs of the respective community.

Wound healing disparities exist among Indigenous populations across the globe. These disparities are often rooted in historical and ongoing socioeconomic, cultural, and healthcare-related factors. Cultural diversity and societal pressure also often dictate formal resource allocation processes to certain health sectors. Some key barriers to wound healing among Indigenous populations include historical trauma, socioeconomic disparities, limited access to healthcare, cultural barriers, chronic health conditions, cultural healing practices, geographic isolation, and healthcare system bias.[36] Many cultures have an honor system in managing their sick, older adult, and chronically ill members. These principles are easier upheld if sufficient resources are available to maintain them.

Many studies have identified a major medical illness as one of the core reasons a family can incur large debts.[37,38] Even in government-run clinics, additional dressing materials or medicines may be charged to the family. Patients and family members may therefore resort to alternative treatment methods (nonallopathic medicine) from local/Indigenous/traditional healers. Although often less costly, these healers may not have the necessary skills or expertise in managing chronic wounds, leading to deterioration.

Loss of independent mobility because of wound chronicity is another major factor that impacts attendance and regular follow-up. Transport availability varies in resource-restricted environments, and walking may be the only way to access a public transport pick-up point. Secluded rural environments are often affected the most and require traveling significant distances to reach a formal healthcare facility.

The social health of the family environment and willingness to incorporate a person with healthcare needs can drive the quality of care/self-care rendered as well as patient safety within a home environment. Because of the social structure and milieu in various countries, family support and social support may differ by culture. Often, as time passes, the financial burden increases; patient independence and activities of daily living (ADLs) achievement deteriorates; dressing changes become more challenging; and caregivers become stressed, fatigued, and exhausted.[39] Late referrals and critical/terminal patient conditions when eventually presenting to formal care are additional aggravating social and behavioral factors that can compound poor wound healing outcomes.

Individuals with wounds treated at home need a designated space to themselves. Wound odor, persistent pain, and a different routine are the main stressors on both the patient and family in settings where space is at a premium. The mere presence of a major skin wound already negatively impacts the patient's own social interactions, relationships, sexuality, and self-confidence. This leads to progressive anxiety and depression that may bring about pessimism regarding perceived treatment benefits. Subsequently, patients have lowered self-efficacy that is often associated with further wound deterioration including eventual lower-extremity amputations.[40]

The real challenge occurs when lifestyle modifications are needed. This often requires additional resources or tailor-made education to construct self-care plans.[40,41] The need for health education and lifestyle modification interventions to have clear rationales cannot be overemphasised. Lifestyle interventions may become a financial, social, and logistical challenge, first to acquire and then to maintain within any restricted living domain. Further, it is a vital step to ensure that any financial help received is correctly allocated to the family member with a wound.

A biopsychosocial approach is necessary in managing wound care for patients in resource-restricted environments. The wound care team, beyond managing the wound, must address the social stressors/factors affecting the patient. Each patient will need a unique, mutually agreed-upon management plan that fits their constraints (medical, financial, family, social, and emotional support).[40]

STATEMENT 3: ABILITY TO HEAL

3A. Healable wound: Determine if adequate blood supply is present for wound healing and that appropriate treatment is available to address the underlying cause(s)

3B. Maintenance wound: Adjust practice if adequate blood supply is present for wound healing but the patient cannot adhere to the plan of care and/or the healthcare system does not have the required resources

3C. Nonhealable wound: Determine alternative wound treatment(s) if blood supply is inadequate and/or the underlying cause cannot be corrected

The process of determining the healing classification of a wound begins with a thorough patient history and physical examination. Identifying the underlying cause(s) of the wound

Table 5. Pain management strategies

Strategy	Comments
Analgesic agents	**Nociceptive pain** • Acetaminophen 500 mg ×2 = 1 g BID or TID (2-3× daily, around the clock) • Nonsteroidal anti-inflammatory agents: use with caution in patients aged >65 y; increased risk of congestive heart failure, gastrointestinal bleeds, creatinine • Start-low dose, frequent monitoring, and titrate as needed for lower adverse effects ◦ Diclofenac (phenylacetic acid derivative): 25, 50, slow release 75 mg (daily maximum, 225 mg) ◦ Ibuprofen (propionic acid derivative): 300, 400, 500 mg (daily maximum, 3× 200 mg) ◦ Indomethacin (indole): 25, 50, SR75 mg (daily maximum, 200 mg) ◦ Naproxen (propionic acid der.): SR750 mg (daily maximum, 1,500 mg) ◦ Celecoxib (Cox-2 inhibitor): 100, 200 mg (daily maximum, 400 mg; increased risk of myocardial infarction, stroke) • Moderate to severe pain may be treated with increasing strengths of opioids (see below)
	Neuropathic pain • Gabapentenoids: short-acting, start low and go slow ◦ Pregabalin: 25, 50, 75, 100, 150 mg 1-4× daily (daily maximum, 600 mg) ◦ Gabapentin: 100, 200, 300, 400 mg (daily maximum, 1,800-3,600 mg) • Tricyclic antidepressants: night use as adjunct in lower doses than usual antidepressants. Second-generation agents have more antinoradrenalin activity than amitriptyline ◦ Nortriptyline or desipramine: 10, 25, 50, 75 mg (daily maximum, 75 mg; often facilitates sleep) • Selective serotonin reuptake inhibitors should be administered by clinicians familiar with their (adverse) effects ◦ Citalopram, fluoxetine, paroxetine, sertraline • Cannabis can be used where it is legally available; cannabidiol is most effective but can be combined with tetrahydrocannabinol to facilitate sleep at night
Analgesic agents to avoid	• Avoid meperidine to treat chronic pain, particularly in older adults, because of the increased risk for seizures
Opioids	• The use of opioid analgesic drugs for persistent non-cancer-related pain remains controversial • Consensus statements from major professional pain organisations endorse their use in appropriate situations • Monitoring adverse effects of opioid therapy should focus on neurologic, gastrointestinal, and cognitive-behavioral effects
Topical	• EMLA (eutectic mixture of local anesthetics) for local procedural pain • Topical diclofenac gel or drops
Nonpharmaceutical	• Local wound care: ensure atraumatic approach • Physical activity • Nutrition (eg, vitamins) • External applications (eg, ointments, massage) • Relaxation/distraction (meditation, music) • Physical therapy (eg, electrical stimulation, heat/cold compress) • Cognitive influence (eg, cognitive-behavioral therapy) • Plant extracts (eg, peppermint oil or cannabis) • Patient involvement (eg, encourage patient "time-outs," allow patient to have some control during the procedure)

is important. Addressing the underlying cause(s) is the first step to developing an achievable management plan.

In some cases, chronic wounds may also become stalled and fail to achieve the wound edge advancement over the set time; these are known as hard-to-heal wounds. They often fall into the maintenance category but, with additional assessment, may be healable with a re-evaluation of the patient, history, causes, and treatment plan.[3,42]

Patient-centered concerns and expectations need to be identified, compared with, and aligned with institutional/clinician resource availability, skills, and immediate intervention options that are available.[3,42] The management plan is based on the assigned healing classification, which may change.

Protect nonhealable wounds against tissue loss, deep and surrounding wound infection, and general deterioration from a wet wound environment. Decreasing moisture is a priority. Maintenance wounds also need protection against further tissue losses with dry wound bed management and local infection controls as the mainstay. Tissue protection may also be a temporary measure until resources become available and additional patient factors are controlled to achieve full optimisation.

Stalled but healable wounds (hard-to-heal) need a second chance to achieve edge advancement with urgency in reassessment and interprofessional team intervention as the highest priorities.[3,42]

STATEMENT 4: LOCAL WOUND CARE: EXAMINE, MEASURE, AND MONITOR

4A. Document wound progress from baseline to establish measurable healing trajectories (paper-based and/or photoimaging, if available).

4B. Cleanse wounds with tepid (preboiled) potable water, saline, or low-toxicity antiseptic agents. Consider soaks, compresses, and irrigation, where appropriate.

4C. Reassess and document wounds regularly at appropriate intervals over time with available resources. Document and maintain confidentiality of the data.

Wound assessment documentation is an integral component of healthcare practice. It is instrumental in ensuring the delivery of high-quality patient care, monitoring wound status, and providing direction for any changes in wound interventions. The comprehensive and accurate recording of wound assessments is essential to ensure improved patient outcomes, effective communication among healthcare professionals, and legal and regulatory compliance.[43]

Monitoring progress. Wound assessment documentation serves as a historical record of the wound's progression over time. By regularly documenting wound characteristics, including size, depth, color, exudate, infection, tissue type, and so on, healthcare professionals can track changes, identify potential complications, and adjust treatment plans. If photo documentation is used, obtain patient consent according to organisational policy, ensure appropriate technique with adequate lighting and appropriate distance from the wound, and include a measuring guide in the photo.[44] This ongoing evaluation is critical for evaluating the effectiveness of interventions and making informed decisions regarding wound management. When measuring surface area or volume, it is imperative to use a consistent technique regardless of technology.

Communication. Accurate wound assessments facilitate effective communication among healthcare professionals. When all team members have access to consistent and up-to-date wound documentation, they can work together to develop and implement a coordinated care plan, ensuring patients receive the best possible treatment. It is vital to use consistent terminology that is common to all disciplines. The *International Classification of Diseases* medical classification system is an example of a globally applicable standard.[45]

Legal and regulatory compliance. Proper wound assessment and documentation are essential to meet legal and regulatory requirements. Inaccurate or incomplete records can lead to legal issues and negatively impact a healthcare professional's practice, even in resource-limited environments.

Reimbursement. In many healthcare systems, proper wound assessment documentation is tied to reimbursement-based funding models. Accurate and detailed records are often necessary to justify the use of specific wound care products or procedures and ensure organisations receive adequate reimbursement for services rendered.

Research and quality improvement. Wound assessment data are a valuable resource for research and quality improvement initiatives. This continuous learning process helps improve global wound care and patient outcomes.

Patient-centered care. Proper wound assessment and documentation are an essential component of patient-centered care. It ensures that patients' conditions are thoroughly evaluated and their treatment plans are tailored to their specific needs. When patients observe that their healthcare provider is committed to documenting and monitoring their wounds, it can enhance trust and patient satisfaction.

To promote language consistency and enhance data clarity, an increasing number of enterprises are creating electronic wound assessment software and applications to reduce the time required for thorough documentation.[43] These programs and applications (some more affordable than others) can provide the healthcare team with a structured set of parameters to ensure all clinical features are documented, thereby enhancing overall communication.[46] Although these tools are an asset to healthcare professionals, they are not without risk, such as incorrect copying and pasting from previous reports/consult notes or patient data security risks. In areas where such programs and applications are not available, updating

the patient and providing written assessment and intervention plans may be warranted.

STATEMENT 5: LOCAL WOUND CARE: DEBRIDEMENT

5A. Healable wounds/cause corrected: Consider active sharp surgical debridement to bleeding tissue with adequate pain control only if it is within your scope of practice. This is undertaken with guidance from advanced wound care expertise only. If not available, consider conservative (sharp) debridement

5B. Maintenance wounds/nonhealable wounds: Consider conservative (sharp) debridement with adequate pain control only if it is within your scope of practice. Only remove loose hanging slough/debris when indicated and without causing any bleeding

5C. Determine if alternative debridement modalities for healable wounds are available (eg, autolytic, mechanical, enzymatic, and maggot biological options)

Debridement is an important process in the WBP paradigm to remove necrotic tissue and other biomaterials, including biofilm, in healable wounds and prevent odor and infection in maintenance wounds. For all wounds located below the knee, communicate the outcomes of any vascular testing (eg, ABPI, waveform) to all members of the interprofessional team, and document accordingly before attempting debridement because many types may be deleterious to the wound bed with reduced vascular supply.

For healable wounds, local wound bed interventions are best determined via the WBP paradigm based on the patient and wound characteristics. Consider surgical debridement (to bleeding tissue) as a first-line intervention. However, in many rural and remote regions, access to a skilled healthcare professional with the necessary education, knowledge, and judgment for this procedure may not exist.

Conservative (sharp) debridement (without causing bleeding) requires advanced knowledge and skills and is more suitable for nonacute care or specialty clinic settings. Only remove loose hanging or unattached debris from the wound without causing trauma to the wound bed.

Clinical sterile maggot debridement therapy is a limited treatment modality in resource-restricted environments, except in cases of accidental exposure. Maggot infestation is often discovered during dressing changes. Good debridement outcomes may result from accidental maggot therapy, particularly if the larvae are from the highly selective *Lucilia sericata/cuprina* bottlefly source, as they focus on devitalised tissue as their food source.[47,48] Detrimental outcomes may present if the infestation is from the ordinary housefly (*Musca domestica*) or other invader species, as those larvae may indiscriminately destroy healthy tissue.[47,48]

Healthcare professionals should assess alternative methods of debridement (eg, autolytic, enzymatic, mechanical) for community sectors, including primary care, home care, and long-term care. Within available resources it is vital to consider patient safety, assess environmental factors, and identify barriers to wound healing before initiating debridement.

Appropriate debridement protocols for maintenance and nonhealable wounds differ significantly from those for healable wounds. Although moist wound healing provides an optimal environment for wound healing, it is a form of debridement (autolytic) that may be detrimental to nonhealable and maintenance wounds. Debridement is generally not a suitable intervention for stable maintenance or nonhealable wounds, because the goal is to keep those dry and free of infection.[49] Consider debridement only when a maintenance or nonhealable wound becomes unstable to remove infected or necrotic wound debris in the most atraumatic manner possible.

Patient goals typically include enhancing comfort, minimising wound-related odor, reducing pain, and improving ADLs. Keeping the wound dry enables the formation of a protective layer, whereas debridement carries the risk of removing this protective layer and introducing pathogenic organisms.

STATEMENT 6: LOCAL WOUND CARE: INFECTION AND INFLAMMATION

6A. Treat local/superficial wound infection (three or more NERDS criteria) with topical antimicrobials

6B. Manage deep and surrounding wound infection (three or more STONEES criteria) with systemic antimicrobials and concurrent topical antiseptics

6C. Consider anti-inflammatory agents in wounds with persistent ongoing inflammation (topical dressings or systemic medication)

The validated NERDS and STONEES criteria can guide the assessment and treatment of infection and inflammation in chronic wounds.[50] Base the diagnosis of infection on clinical signs and symptoms rather than superficial wound swabs, which should be used only to guide antimicrobial selection in the event of an infection. If deep and surrounding tissue infection is suspected, identify the bacterial species and their sensitivity to commonly used antibacterial agents to help guide systemic antimicrobial use. This is especially true if a deep and surrounding infection is not responding to the empiric treatment.

The best tissue samples for wound bed culture swabs are obtained after cleaning the wound with potable water or saline and sampling the wound base without debris. A culture from tissue samples using a curette or other biopsy technique is most likely to represent the organisms in the wound tissue. Alternately, a semiquantitative swab technique using the Levine method can correlate to tissue biopsies.[51] The swab is placed on granulation tissue and pressed enough to extract wound exudate and then rotated 360° to cover all surfaces of the swab. Placing the swab in the transport media to premoisten it prior to placing the swab on the skin may increase the bacterial yield for patients with low-exudate wounds.[52]

Pathogenic bacteria may infiltrate to the bone and cause osteomyelitis, which derails healing potential and is challenging to cure. A bone biopsy is the criterion standard to diagnose suspected osteomyelitis, because superficial cultures do not access the deep bone tissue, and imaging is limited by variable specificity.[53] However, a bone biopsy may be uncomfortable, is dependent on skilled clinicians, and may extend the tissue damage. For these reasons, it frequently is not a feasible option, even more so if resources are scarce.

When deep wound infection is confirmed, antimicrobial dressings are appropriate to locally support systemic antibiotic therapy and prevent spread to the deep and surrounding compartment from surface bacteria. The five most common choices of antimicrobial dressings are silver, polyhexamethylene biguanide, iodine, methylene blue/crystal violet, and honey. Of these, silver and honey have additional anti-inflammatory properties.[54]

In some wounds, broad-spectrum antiseptics are applied for short-term rapid bacterial burden reduction to support systemic antibiotics. When the risk of infection outweighs the cytotoxic properties, low-cost povidone-iodine-moistened gauze changed daily over exposed bone can reduce surface bacteria. This is a short-term strategy accompanied by clinical evaluation for serum thyroid function levels especially when wound surfaces are large. However, with the newer low-toxicity antiseptics, other options are now available that are less aggressive but equally effective.

In general, wounds in immunocompetent patients that present for less than 1 month are treated with agents for Gram-positive coverage. Polymicrobial infections (typically seen in PWDs) or wounds longer than 1 month in duration call for broad-spectrum agents with Gram-positive, Gram-negative, and anaerobic coverage because these patients are often also immunocompromised.[55]

Cytotoxic agents may be appropriate for nonhealable wounds if the need for topical antimicrobial action is greater than the tissue toxicity. Antiseptics are generally preferred over topical antibiotics as part of antibiotic stewardship because of a lower risk of systemic bacterial resistance and adverse effects associated with contact irritant or contact allergic dermatitis.[54]

6D. Gently cleanse the wound with low-toxicity solutions (water, saline, noncytotoxic antiseptic agents).

The cleansing solution used depends on the characteristics of the wound and availability in practice. There is poor consensus in the literature on wound cleansing recommendations. An updated 2021 Cochrane review on cleansing solutions of venous leg ulcers concluded that there is a lack of randomised controlled trial evidence "to guide decision-making about the effectiveness of wound cleansing compared with no cleansing and the optimal approaches to cleansing of venous leg ulcers."[56] However, general wound care principles involve low-toxicity solutions including potable or preboiled water, saline, and other wound-friendly antiseptic agents.[57] This avoids cytotoxic effects and damage to healthy granulation tissue in healable wounds.

Acetic acid diluted to 0.5% to 1.0% or hypochlorous acid can also be used in some cases in which an acidic environment is preferred (eg, for topical treatment of *Pseudomonas aeruginosa*).[58] Based on the healability classification of the wound, antiseptic agents with some tissue cytotoxicity may be used after a positive risk-benefit assessment. This includes agents such as low-concentration chlorhexidine or its derivative polyhexamethylene biguanide and povidone-iodine. This may be beneficial in cases of maintenance and nonhealable wounds that have a high potential for infection. Further, these agents can be used to manage odor and exudate in addition to controlling bioburden. In resource-limited environments, consider wound hygiene measures and how solutions are prepared, stored, and distributed to patients to prevent cross-contamination.

There is emerging interest in the use of surfactants to remove biofilms that often exist within wound debris and have two surfaces of different viscosity (Supplemental Table 2, http://links.lww.com/NSW/A177). Wound irrigation remains a controversial topic for use in chronic wounds. However, expert opinion is not to irrigate wounds if the base of the wound is not visible to avoid accumulation of the irrigation solution in closed spaces and accidental enlargement of the wound.[57] Irrigate wounds with an adequate solution volume (50-100 mL per centimeter of wound length).[59]

STATEMENT 7: LOCAL WOUND CARE: MOISTURE MANAGEMENT

7A. Maintain moisture balance in healable wounds with hydrogels, films, hydrocolloids, hydrofibers, alginates, and foams

7B. Institute moisture reduction with fluid-lock mechanisms in healable wounds using superabsorbents to wick moisture away from the surface (diaper technology)

7C. Determine if wound packing is needed for healable wounds. It could be wet (donate moisture) or dry (absorb moisture)

7D. Establish a targeted moisture reduction protocol in maintenance and nonhealable wounds to reduce bacterial proliferation

Maintaining moisture balance is complex and depends on the wound type and healing classification. Consider moisture balance, infection control, and patient education in selection of dressing materials.[60] Incorporating and tailoring moisture management strategies to the specific wound type and the resources available can optimise patient outcomes and minimise complications (Table 6).[3,54] Further research and clinical studies should continue to refine our understanding of wound moisture management to enhance wound care practices in the future.[3,54]

In general, as the level of exudate increases, so should the moisture absorbency or transferring capability of the dressing.[3] Moisture-balance dressing options can be combined with antibacterial and anti-inflammatory properties to further meet the wound needs.

The choice of dressing for maintenance and nonhealable wounds should prioritise comfort while avoiding fluid donation to the wound bed and maceration of the wound edges. These wounds require regular reassessment for any progress or deterioration and should be managed to reduce bacterial load. Depending on wound evolution and characteristics over time, dressings may need to be adapted.

STATEMENT 8: HEALING TRAJECTORY

8A. Consider that healable wounds should be at least 20% to 40% smaller by week 4 to heal by week 12. If factors are present that affect healing time (poor glycemic control, for example), additional healing time may be required

8B. Allocate additional time to healing beyond 12 weeks in healable wounds if there are limited available resources, and continue with consistent care

8C. Prioritise referral to specialist centers (when available) for diagnostic testing and/or a skin biopsy, especially when faced with severe resource restrictions

Wound healing trajectories are useful and necessary for evaluating the needed time to heal, especially using clinical data (measurements) for both acute and chronic wounds. The healing trajectory is based on accurate and consistent wound measurements that determine the wound surface area closure over time. This helps to distinguish wound progression, stalled wounds, and worsening wound status.

Healable acute wounds should be completely closed within 30 days. Expect chronic healable wounds to have a 20% to 40% edge advancement at 30 days (4 weeks) and to close within 12 weeks.[3,42,61,62] Nonhealable wounds have no defined time allocated to close, no edge advancement is expected, and all initiated steps are to prevent further deterioration. Maintenance wounds are not expected to heal nor deteriorate, and wound healing may progress slowly without a fixed time expectation unless patient/institution/system optimisation is achieved.

Re-evaluate hard-to-heal wounds periodically for alternate diagnoses. In these cases, consider wound biopsy, further investigation, and/or referral to an interprofessional assessment team. A healing trajectory can be assessed in the first 4 to 8 weeks to predict if a wound is likely to heal by week 12, provided there are no new complicating factors.[63] Changes in the wound, the individual, or the environment may necessitate the reclassification of a wound to the maintenance or nonhealable category.

STATEMENT 9: EDGE ADVANCEMENT

9A. Consider locally constructed active modalities according to the required mechanism of action and the specific indications for initiating an adjunctive therapy to support wound healing

9B. Decide on adjunctive therapies through an interprofessional team approach and include a prior risk-to-benefit analysis

Table 6. Goals of moisture management based on wound healability[3,42,54]

Healability Status	Main Emphasis	Strategies
Healable	Optimal moisture balance within the wound bed	• Match topical dressing type to the moisture needs of the wound to help maintain a moist environment, facilitate autolytic debridement, and support cell migration • Regular monitoring of the moisture level to adjust interventions as the wound heals • Provide a barrier against external contaminants while allowing excess exudate to be absorbed and protect the wound edges against maceration • Educate patients on signs of infection or excessive moisture to enable early recognition and prevent complications
Nonhealable	Moisture and bacterial reduction	• Address bacterial load within the wound bed. Antimicrobial dressings, bactericidal compress/soak/irrigation, and systemic antibiotics may be necessary • Absorbent dressings are beneficial in creating dry wounds beds with no moisture interaction • Address malodorous exudate with odor-controlling dressings or topical agents • Shift priorities in cases where complete healing is not feasible to focus on symptom management and patient comfort
Maintenance	Moisture and bacterial reduction	• Address bacterial load within the wound bed. Antimicrobial dressings, bactericidal compress/soak/irrigation, and systemic antibiotics may be necessary • Excessive exudate can hinder healing and create autolysis and wound edge expansion. Dressings with minimal moisture interaction are needed to keep wounds drier and more stable • Addressing odor is crucial and should include odor-controlling dressings or topical agents • Address system and patient issues and modify plans to optimise both patient and resources accordingly

Select adjunctive therapies according to healability. Initiate these as soon as possible after injury in persons with major trauma to prevent sequelae of long chronicity. Select modalities using an interprofessional team approach based on what is available and the physical mechanism required (while ensuring trauma tissue healability). In hard-to-heal wounds, the wound may need a second chance to heal after reassessment.[42] Ensure informed consent is a part of adjunctive therapy decisions.

A risk-to-benefit and cost-effectiveness analysis is helpful and will add in system sustainability. The key to effective adjunctive modality decisions is based on the risk it poses to initiate the therapy (physical discomfort, financial hardship, patient adherence) versus the benefit it will provide (tissue oxygenation, wound contraction, edema reduction, cellular reactivation).[42,64] The best risk-benefit decisions are made within an interprofessional team including the patient, ensuring group commitment and treatment completion within optimal use of resources.

Optimising resources, or the slight repurposing thereof, may lead to creative strategies in the hands of interprofessional teams to tailor-make solutions to ensure all patients are optimally treated despite resource restrictions.

Surgery. Even in the most restricted environments, this is the one modality that is mostly available within a medical catchment area, often in tertiary care settings with referrals received from primary care clinics to provide debridement, general surgery with primary/tertiary intention closure, skin grafts, and/or amputations.

Skin grafts may be available in resource-restricted environments as an advanced modality to achieve tissue closure to reduce healing times and prevent recurrent deep wound infections. The procedure can minimise the extensive use of dressing materials over a prolonged period and reduce primary care chronic wound workload. Skin graft decisions are often made to preserve body functionality and promote early wound closure above aesthetic outcomes.[65] However, avoid skin grafts for ischemic wounds and most venous stasis ulcers; consider them only in wounds where a favorable outcome could be expected.[66,67]

Electrical stimulation. Wound healing can be accelerated by enhancing the natural electrical current present in injured skin. In resource-limited environments, this modality should be investigated for wound healing because of its high-level evidence base and availability of devices of this nature (direct current, alternating current, low-intensity direct current, pulsed electromagnetic fields, high-voltage pulsed current, and transcutaneous electrical nerve stimulation devices). The evidence supports increased cellular proliferation and increased microcapillary perfusion, as well as a reduction in bacterial burden and infection on treated wound beds.[68]

Wall-mounted negative-pressure wound therapy. This can give the healthcare professional control over exudate management and accuracy in fluid replacement for inpatients with high exudate and large tissue defects. Start with the lowest possible pressure (minus 50-80 mm Hg). The patient becomes bedbound for the modality to be maintained, and the base layer (often gauze or petrolatum-impregnated dressings) needs to be replaced at least daily. This, together with starting on the lowest possible negative-pressure setting, will prevent mechanical trauma to the wound bed from tissue adherence and traumatic dressing removal in cases where nonadherent base layers are not available.[69] There are now disposable negative-pressure wound therapy devices designed for use in the community as well as do-it-yourself options that can render acceptable clinical outcomes.[70,71]

Breathing high-flow, highly concentrated oxygen. Oxygen is often overlooked as a legitimate wound healing modality.[72] Ironically, it is rarely used, although nearly all formal healthcare settings have copious amounts of oxygen available, even in relatively resource-poor environments. The availability of oxygen concentrators has also increased because of the COVID-19 pandemic, making oxygen administration also a possibility on an outpatient basis in home-based settings.[73] Although hyperbaric oxygenation is the most effective means of increasing plasma oxygen concentration and tissue oxygen delivery, this modality is not always readily available. However, providing normobaric (ward) oxygenation still produces a 7.5-fold increase in plasma-borne oxygen (ie, from 0.3 mL/dL to 2.3 mL/dL; Table 7).[74] Moreover, intermittent inhalation of 100% oxygen in patients without chronic obstructive pulmonary disorder (eg, 6 hours on/2 hours off by nonrebreather mask) over 3 to 4 days is not harmful to the lungs and may provide significant additional oxygen substrate, while the intermittent increase and decrease in oxygen delivery activate the expression of hypoxia-inducible factor (a strong stimulus for angiogenesis).[75] This would suggest that in lieu of hyperbaric oxygen therapy, normobaric oxygen is justified for mitigating conditions on the FDA-approved list of indications for hyperbaric oxygen (Table 7).[76] This may include tissue reperfusion injuries (eg, crush injuries, compartment syndromes before and after surgical release); bacterial toxin inhibition (ie, infective myonecrosis or other anaerobic infections); or large-tissue defects (after debridement to maintain the reactivated inflammatory response for up to 48 hours). Normobaric oxygen provides 50% of the Po_2 of typical hyperbaric oxygen therapy (at 2 atmospheres); however, many of the pharmacologic effects of oxygen are achieved only under hyperbaric dosages.[77,78]

Note that topical oxygen administration directly to a wound does not have the same physiologic effects attributed to systemic oxygen delivery.[79] Topical oxygen delivery systems remain subject to ongoing research to determine their beneficial actions beyond improved epithelialisation and possibly a mild antiseptic effect.[64] The latter effect has also been attributed to ozone therapy.[80] A systematic review completed in 2018 indicated that these therapies could potentially elicit mild oxidative stress or disinfection but that the risk of toxicity due to uncontrolled reactive oxygen species

is high.[81] Within the limited-resource environment, these devices and use thereof are likely uncontrolled.

STATEMENT 10: HEALTHCARE SYSTEM CHANGE

10A. Facilitate evidence-informed, culturally competent, and equitable care for all patients

10B. Improve provider skills for wound management competency to enhance patient outcomes

10C. Establish timely and effective communication that includes the patient and all interprofessional wound care team members for improved healthcare system wound outcomes

Globally, chronic wound management consumes a significant portion of healthcare resources; preventive care represents the most cost-effective strategy for reducing healthcare system expenditures. There are numerous approaches to integrating preventive care into practice. For instance, DFUs are notorious for leading to high amputation rates and morbidity worldwide, even though many DFUs are preventable. Although diabetes was initially believed to be most prevalent in developed countries, it is noteworthy that 80% of diabetes-related deaths occur in countries with limited resources.[82] A validated screening tool, an educated and available interprofessional team, and the implementation of prevention algorithms can be used in countries regardless of the availability of resources.[83-85] Other organisational strategies that could be implemented include the following.

Patient navigation. Managing a DFU requires continual support from a circle of care that includes family members and healthcare professionals (including home care and wound care) working as a team. Timely access to both health and social services is often necessary to prevent and heal DFUs. Regionalised, community-based integrated diabetes services linked to interprofessional wound care clinics are proving to be most successful.[86]

One effective way to ensure optimal and timely care is patient navigation. This concept is adaptable to all healthcare sectors and can improve the timely diagnosis and treatment of wound infections, optimise pain management, and increase access to specialised care, thereby expediting wound closure rates.[87] Patient navigation is becoming a vital component of integrated care, facilitating seamless transition between sectors and enhanced clinical outcomes. Further, it is accompanied by a boost in morale for both patient and healthcare professional, decreased nonacute hospital admissions or readmissions, enhanced patient quality of life, and improved adherence to treatment protocols. All these factors combined generate significant cost savings to healthcare systems.[87,88]

A critical element of successful patient navigation programs is the inclusion of a comprehensive and systematic approach to guide healthcare professionals in assessing and delivering care to each individual patient (eg, the WBP framework). These pathways do not need to be complicated or time consuming, but should ensure specific criteria are met, including regular foot care for those at high risk of amputation, glycemic control to an HbA_{1c} less than 9%, and a BP less than 130/90 mm Hg.[23,89]

Table 7. Normobaric oxygen therapy mechanisms and delivery systems

Delivery System	Goal	Range	Caution
Nasal cannula	Low flow and low concentrations of oxygen	1 LPM = 24% 2 LPM = 28% 3 LPM = 32% 4 LPM = 36% 5 LPM = 40% 6 LPM = 44%	Do not exceed 6 LPM: prevent dryness
Medium concentration masks	Medium flow and medium concentrations of oxygen	5-6 LPM = 40% 6-7 LPM = 50% 7-8 LPM = 60%	To avoid carbon dioxide mask buildup: rates over 5 LPM
High concentration (partial rebreather)	High concentrations of oxygen with the addition of a reservoir bag	8-12 LPM = 60%-80% 6-7 LPM = 50% 7-8 LPM = 60%	Reservoir bag never to deflate more than one-third
Nonrebreather mask with one-way valves	99% oxygen through the addition of reservoir bag	8-15 LPM = 90%-95%[a]	Reservoir bag to remain fully inflated. Consistent patient monitoring needed
Multiple concentrations (Venturi)	Exact concentrations of oxygen by Venturi system	24%, 26%, 28%, 30%, 35%, 40%, 50%	For flow and air/oxygen ratios, refer to instructions on the mask

Abbreviation: LPM, liters per minute.

[a]Hazards: pulmonary oxygen toxicity (only after more than 16-24 h on 100%), oxygen-induced hypoventilation, absorption atelectasis, retrolental fibroplasia in premature infants, fire.

Policy interventions. Organisational policies that detail and provide guidance on best practice interventions and pathways are crucial for the successful and sustainable implementation of wound care protocols. Base these policies on current published guidelines for each specific wound type and translate them into the environment they need to serve. The institution needs to accept them as standards of practice and be approved as such to serve as evidence-based care in environments in which other guidelines may not be successfully adopted because of cultural or language translation challenges. Further, these policies must clearly outline the process for entering and using data, as ongoing quality improvement initiatives are based on data to improve and maintain effective care processes.

Adapted wound care. Although the delivery of care should be adapted to the unique needs of each healthcare sector, certain concepts should be standard, particularly those that enhance effective communication both within and across sectors. The increased adoption of digital technology expedites assessments, enhances access to specialised care, and optimises the allocation of limited resources.[90] Where adaptations are implemented as care processes, these practices should be well documented as care standards and be easily accessible to ensure consistency and continuity of care within respective institutions.

DELPHI CONSENSUS HIGHLIGHTS

Some important comments from the panel:

- The ability to heal (healability) is a changeable modality and not to be seen as a static classification as patient condition, circumstances, and choices drive the classification allocation process (3A).
- The adjustment of practice as required in maintenance wounds incorporates the establishment of a conservative wound bed approach, with attention to the allowances the patient is willing to make within their life choices to slowly ensure patient optimisation and subsequently increase host competence (3B).
- When the method of patient documentation is agreed upon within an institution, it should be uniformly used to prevent communication gaps between providers that may inadvertently cause a negative impact on patient care outcomes (4A).
- Antiseptic mouth washes suitable for mucosa are often also friendly for use on a wound bed (4B). This may be considered off-label use.
- The choice for topical bacterial burden control should be on topical (low) toxicity antiseptics (the five most important ones), depending on the ability to heal and bacterial burden priorities to be addressed. Refrain from using topical antibiotic preparations, ointments, and creams on chronic wounds because those preparations are often focused only on Gram-positive organisms and would allow Gram-negative and anaerobic organisms on the wound bed to multiply freely. Further, topical antibiotic preparations need only one mutation to create systemic resistance to the targeted organism. Topical antibiotics are often in a carrier medium that is associated with contact irritant or contact allergic dermatitis (6A and 6B).
- When a healable wound has a significant moisture burden and remains in need of superabsorbent dressings to control the moisture balance of the wound bed, the wound needs thorough reassessment to ensure all underlying causes have been corrected for (7B).
- In establishing an interprofessional team, use any means of communication to build and maintain such a team as that could significantly optimise local capacity despite distances between providers and specialists to increase clinical outcomes despite local limitations (9B).

CONCLUSIONS

Optimise chronic wound care in resource-limited environments by initiating small adaptations and creative interventions without compromise to the core principles of care required. Interprofessional wound care teams can serve as a virtual resource to isolated and remote communities to improve clinical outcomes. All of the critical elements for (diabetic) foot management and care can easily be incorporated into diverse environments by increasing local capacity and providing clinician education and culturally appropriate patient empowerment.

PRACTICE PEARLS

- The holistic care of PWDs includes the optimisation of HbA_{1c} levels, BP, cholesterol levels, and drugs with cardiac- and renal-protective properties.
- The audible handheld 8-MHz Doppler pulse signal is a suitable bedside test for arterial blood supply to the lower limbs. It can be performed as a modification of the traditional ABPI, and the pulse sounds are easy verifiable by remote expert team members using MP3 or MP4 recordings from a cellphone.
- The NERDS and STONEES mnemonics can guide diagnosis and treatment of local/deep and surrounding infection, including an oral antibiotic indication for osteomyelitis.
- Plantar pressure redistribution can be accomplished from innovative, less costly alternatives such as soft felted simple inserts, to the total contact cast and removable cast walker made irremovable if the latter are unavailable or unsuitable for patient preferences or ADLs.
- Integrated coordinated care teams can connect with virtual expertise by equipping healthcare professionals with skills in patient navigation.
- Toolkits containing enablers for practice along with 8-MHz Dopplers and infrared thermometers can facilitate care in resource-limited settings.

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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Supplemental Table 1. Delphi consensus achieved among 41 contributors on 32 wound bed preparation (WBP) 2024 statements

WBP 2024 statements with 100% "strongly agree" consensus
10C. Establish timely and effective communication that includes the patient and all interprofessional wound care team members for improved healthcare system wound outcomes.
WBP 2024 statements with 100% "strongly agree" or "agree" consensus
1C. Triage the most important causes/comorbidities to treat immediately and design targeted intervention(s) within locally available support systems/resources.
2A. Assess pain using a pain scale with a targeted plan for nociceptive and/or neuropathic pain management.
2B. Identify activities of daily living that may affect healing outcomes.
2D. Empower patients using sustainable educational interventions that include their support system. When possible, use the patient's primary language and consider their cultural background, religion, accepted behaviors, taboos, and beliefs.
4A. Document wound progress from baseline to establish measurable healing trajectories (paper-based and/or photoimaging, if available).
4C. Reassess and document wounds regularly at appropriate intervals over time with available resources. Document and maintain confidentiality of the data.
6A. Treat local/superficial wound infection (three or more NERDS criteria) with topical antimicrobials.
7C. Determine if wound packings are needed for healable wounds. It could be wet (donate moisture) or dry (absorb moisture).
7D. Establish a targeted moisture reduction protocol in maintenance and nonhealable wounds to reduce bacterial proliferation.
8A. Consider that healable wounds should be at least 20% to 40% smaller by week 4 to heal by week 12. If factors are present that affect healing time (poor glycemic control, for example) additional healing time may be required.
8B. Allocate additional time to healing beyond 12 weeks in healable wounds if there are limited available resources and continue with consistent care.
8C. Prioritise referral to specialist centers (when available) for diagnostic testing and/or a skin biopsy, especially when faced with severe resource restrictions.
9B. Decide on adjunctive therapies through an interprofessional team approach and include a prior risk-to-benefit analysis.
10A. Facilitate evidence-informed, culturally competent, and equitable care for all patients.
WBP 2024 statements with more than 95% "strongly agree" or "agree" consensus
1A. Assess for adequate arterial perfusion to ensure proper wound healing (palpable foot pulse[s] and/or multiphasic arterial foot artery sounds with an 8 MHz Doppler).
1B. Identify all underlying causes.
2C. Assess patients for (harmful) lifestyle habits that may impact wound healing (eg, smoking, alcohol, and other substances).
3B. Adjust practice if adequate blood supply is present for wound healing but the patient is unable to adhere to the plan of care and/or the healthcare system does not have the required resources. This is a maintenance wound.
4B. Cleanse wounds with tepid (preboiled) potable water, saline, or low-toxicity antiseptic agents. Consider soaks, compresses, and irrigation, where appropriate.
6B. Manage deep and surrounding wound infection (three or more STONEES criteria) with systemic antimicrobials and concurrent topical antiseptics.
7A. Maintain moisture balance in healable wounds with hydrogels, films, hydrocolloids, hydrofibers, alginates, and foams.
7B. Institute moisture reduction with fluid-lock mechanisms in healable wounds using superabsorbents to wick moisture away from the surface (diaper technology).
10B. Improve provider skills for wound management competency to enhance patient outcomes.
WBP 2024 statements with more than 90% "strongly agree" or "agree" consensus
1D. Prioritise redistribution of pressure for foot wound(s) and choose appropriate compression for leg/foot edema based on arterial perfusion.
3A. Determine if adequate blood supply is present for wound healing and that appropriate treatment is available to address the underlying cause(s). This is a healable wound.
3C. Determine alternative wound treatment(s) if blood supply is inadequate and/or the underlying cause cannot be corrected. This is a nonhealable wound.
5A. Healable wounds/cause corrected: Consider active sharp surgical debridement to bleeding tissue with adequate pain control only if it is within your scope of practice. This is undertaken with guidance from advanced wound care expertise only. If not available, consider conservative (sharp) debridement.

5B. Maintenance wounds/nonhealable wounds: Consider conservative (sharp) debridement with adequate pain control only if it is within your scope of practice. Only remove loose hanging slough/debris when indicated and without causing any bleeding. 6C. Consider initiating anti-inflammatory agents in wounds with persistent ongoing inflammation (could be topical dressings or systemic medication). 9A. Consider locally constructed active modalities according to the required mechanism of action and the specific indications for initiating an adjunctive therapy to support wound healing.
WBP 2024 statements with more than 85% "strongly agree" or "agree" consensus
5C. Determine if alternative debridement modalities for healable wounds are available (eg, autolytic, mechanical, enzymatic, and maggot/biological options).

Supplement Table 2. Common antiseptic agents for nonhealable wounds

Agent	Toxicity, low to high[a]	Effects
Chlorhexidine (polyhexamethylene biguanide; PHMB)	• Low • Chlorhexidine contraindicated in eyes/ears but PHMB is most common preservative in eye and ear drops	• Neutral, non-release (chlorhexidine tulle gras) • PHMB gauze, foam is nonrelease and does not treat wound surface • Kills bacterial cell wall–no bacteria left for resistance
Povidone iodine	• Low Less toxic with slow-release formulations	• Pro-inflammatory • Treats wound surface • Broad spectrum • Good penetration of biofilm glycocalyx
Acetic acid (diluted to 0.5%–1.0%), hypochlorous acid	• Moderate	• Lowers pH of wounds (bacteria thrives in alkaline environment) • Pseudomonas will be inhibited in an acid environment • Disinfectants
Saline, potable water	• Neutral	• Not antibacterial
Dyes: Scarlet red, Proflavine	• Toxic	• Select out gram-negatives
Sodium hypochlorite	• Toxic = bleach	• Most toxic in alkaline formulations, less toxic with lower pH
Hydrogen peroxide	• High toxicity	• Action = fizz that happens for a short period only • Caution with deep wounds and open vessels (can cause air emboli)
Quaternary ammonia–Cetrimide	• Very high toxicity	• Other alternatives are less toxic

Note. Color legend: green–low-toxicity; yellow–neutral; pink–high toxicity.

[a]Cytotoxicity is less important than antimicrobial action.