INTERNATIONAL **CONSENSUS DOCUMENT**

Wounds INTERNATIONAL

DIABETIC FOOT ULCER CARE

IN THE ASIA-PACIFIC REGION

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FOREWORD

The global prevalence of diabetes and diabetic foot ulcers (DFUs) is increasing, with growing threat of morbidity, amputation and mortality. In the Asia-Pacific (APAC) region, this issue is particularly urgent. The International Diabetes Federation (IDF) estimates that there were 537 million people living with diabetes globally in 2021, and that this number will increase to more than 700 million by 2045; Western Pacific and Southeast Asia regions are included in the area where diabetes is expected to increase most rapidly (IDF, 2021). Up to a third of people with diabetes worldwide will develop a DFU over the course of their lifetime, and direct costs of diabetes-related care was $237 billion in 2017 (Armstrong et al, 2017; Armstrong et al, 2020).

There are factors unique to the APAC region—cultural, geographical, health-related and socio-political—which require specific considerations. In the APAC region, too many people, especially women, are unable to receive the medical treatment they need due to high costs and difficulties in seeing a clinician or health care provider in rural areas. High prevalence of diabetes in the APAC region accounted for over 60% of the 5.1 million deaths caused by diabetes globally in 2013 (Organisation for Economic Co-operation and Development [OECD], 2020). Moreover, of the 215 million people living with diabetes in the region, half of them are underdiagnosed and unaware of long-term diabetic complications. To address these issues, a group of experts from the APAC region convened for an online meeting in August 2022 to develop this international consensus document, focusing on the assessment and treatment of DFUs to prevent infection and other complications.

This consensus document aims to:

- Provide an overview of the growing burden of DFUs in the APAC region
- Provide a framework for accurate assessment and diagnosis
- Clarify the need for thorough evaluation, including testing and diagnostic technology
- Provide a clinical pathway for use in practice, tailored for use in the APAC region
- Provide guidance for management of complications such as infection, focusing on an antimicrobial stewardship (AMS)-informed approach
- Add to the evidence base and guidelines available in the APAC region
- Focus on education and the future, in order to tackle the growing problem of DFUs and improve outcomes.

The guidance in this document aims to equip clinicians to deal confidently with DFUs and any associated complications, with the emphasis on the patient and providing patient-centred care. The overall aim is to improve outcomes for patients and their quality of life.

Harikrishna K.R. Nair, Chair

Overview of DFUs

Diabetic foot ulceration is a preventable complication of diabetes that imposes a significant burden on individuals and communities. If left untreated, or not treated appropriately, DFUs may lead to amputation and increased disability, with poor outcomes and significant implications for the individual, their family and carers, the community and health systems (Jogheea-Jutton et al, 2022).

Diabetic foot is defined as a foot affected by ulceration that is associated with neuropathy and/or peripheral arterial disease of the lower limb in a patient with diabetes (Alexiadou and Doupis, 2012).

The global prevalence of DFU among people with diabetes is estimated at 3–13%, increasing with age and duration of diabetes (Zhang et al, 2016; Al-Rubeaan, 2015). Neuropathic DFUs are more likely to heal within a timeframe of 20 weeks, while neuro-ischaemic ulcers take longer and will more often lead to limb amputation (Katsilambros et al, 2010). It has been estimated that DFUs precede approximately 85% of all amputations performed in diabetic patients (Moxey et al, 2011).

Due to the significant impact of DFUs, particularly on patient outcomes and quality of life, appropriate and timely management of DFUs is of paramount importance, with a focus on prevention and education wherever possible. Developing a DFU is a pivotal event in the life of a person with diabetes and a marker of serious disease and comorbidities; individuals who develop a DFU are at greater risk of premature death, myocardial infarction and fatal stroke (Brownrigg et al, 2012). DFUs are also associated with a risk of hospitalisation and resource allocation that is at least equivalent to other major chronic diseases such as heart disease, stroke, and cancer (Skrepnek et al, 2017). Common indicators of diabetes-related resource utilisation include hospitalisations, outpatient care, emergency room visits, prescription drugs, common procedures, laboratory testing, dietary consultations, and ophthalmology exams (Huang et al, 2004).

DFUs in the APAC region

The impact, prevalence, and costs of DFUs vary across the APAC region; however, the Western Pacific and Southeast Asia regions have been identified as key regions where diabetes is expected to increase most rapidly (IDF, 2021). Needs of patients vary across the region, with variations in dietary and lifestyle factors, such as smoking, carbohydrate, sugar-heavy diets, and sedentary lifestyles. There are also key differences between rural and urban areas and associated access to healthcare. Some parts of the region are particularly affected by rapidly ageing populations and increasing prevalence of comorbidities, such as diabetes but also heart disease, hypertension, and other vascular issues. In some geographical areas, infection rates in DFUs are particularly high.

It is important to acknowledge that, in many cases, DFU data in the APAC region is either unavailable or unreliable. Few studies have examined the recent trajectory of DFU development in the APAC region; however, a study in Thailand found that the prevalence of peripheral arterial disease (PAD) among Thai patients had increased significantly, resulting in increased rates of DFUs, plus lower healing rates and increased rates of amputation (Thewijitcharoen et al, 2020).

In low- and middle-income countries (LMIC), anecdotal evidence from clinicians suggests that patients tend to know little about their DFUs and do not have the resources for effective self-care. Alongside cultural views, resource-based restrictions can hinder treatment and management of DFU (Hunt, 2019). More education is required to protect patients and help them to protect themselves. In the Philippines, there has been a focus on patient and carer education programmes; however, these programmes were suspended due to the COVID-19 pandemic, resulting in an increase in amputation rates. Subsequently, there is an urgent need to recommence this initiative ensuring education is

delivered to patients, carers, and clinicians to help reduce the increased burden and cost, both to individuals and healthcare systems.

A study in Malaysia found that the total cost per patient per annum was MYR 5981 in the public setting and MYR 8581 in the private setting. In the public setting, outpatient visit costs represent 50% of the overall cost, followed by medical devices, which represent 38% of total costs. In the private setting, as in the public, outpatient visits and devices contribute the most to overall costs with 51% and 21%, respectively. However, hospital inpatient costs are higher in the private setting and represent 14% of the total costs versus 5% in public setting (Nair et al, 2022).

In rural areas, there may be increased barriers to receiving DFU prevention information and care. A study across Asia found that factors affecting the patient's level of care could be categorised into modifiable factors (e.g. education level, socioeconomic status, social support) and non-modifiable factors (e.g. age, presence and severity of comorbidities restricting ability to self-care, past experiences). These precipitating factors could be further categorised into patient factors (e.g. degree of reception of information, presence of psychological barriers), provider factors (e.g. presence and degree of multi-disciplinary approach to care, presence of administrative inconveniences) and disease factors (e.g. presence of diabetic sensory neuropathy, complexity of disease process). Overall, the study found that important but varying barriers to care existed across the region (Rerkasem, 2011; Sayampanathan et al, 2017).

The barriers to care underline the need for a multidisciplinary team (MDT) approach, and the need to educate and engage patients in their own care in order to optimise DFU prevention and management (Figure 1).

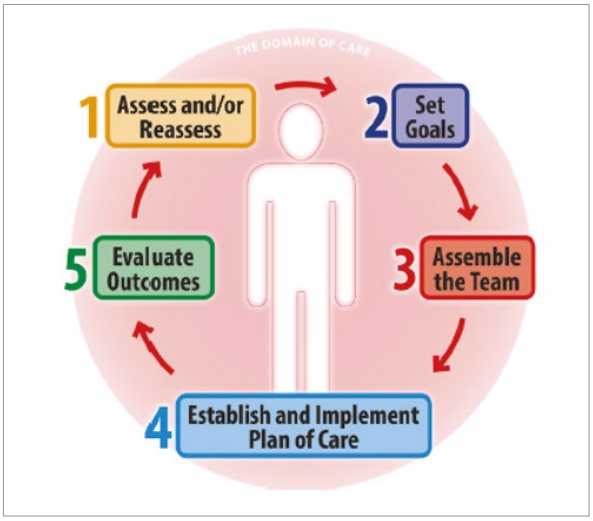


FIGURE 1 | The Wound Prevention and Management Cycle (Bassett et al, 2019; taken from WUWHS, 2020a)

The importance of assessment

Accurate assessment is vital to target treatment appropriately and ensure the patient's needs are being met. Thorough and accurate assessment is also needed to reduce variations in practice and improve patient outcomes (WUWHS, 2020b). See Box 1 for strategies to reduce practice variation.

Box 1. Strategies to reduce practice variation

- Discontinue ineffective or inefficient treatments
- Improve the assessment skills of all healthcare professionals
- Implement consistently appropriate findings from research and evidence-based best practices
- Share best practice and audit results with healthcare professionals and with the general public
- Support patient engagement in evidence-based best practice

Holistic assessment is vital and requires examining the whole patient, their health, limb and skin integrity. Holistic assessment is particularly important because it addresses underlying causes and identifies any barriers to healing at the point of assessment, allowing subsequent treatment to be tailored to the individual patient (WUWHS, 2020b). In addition to evaluating the DFU itself, a holistic framework should include evaluation of the patient's general health, wellbeing and lifestyle, overall skin heath and integrity, tissue perfusion, and the periwound skin (Nair et al, 2020). As DFUs are a manifestation of complex, chronic systemic disease, it is particularly important that a holistic assessment is undertaken (Gulf Diabetic Foot Working Group, 2017; IWGDF, 2019).

A detailed patient history should be obtained and include (adapted from WUWHS, 2016):

- Past medical and surgical history
- Diabetes management and blood glucose control, plus any other concurrent conditions or illnesses
- Symptoms and signs of peripheral arterial or venous disease
- Symptoms and signs of peripheral neuropathy
- Musculoskeletal evaluation (e.g. for overall flexibility, range of movement in the ankle, foot shape
- Systemic signs of infection
- Pain (e.g. neuropathic pain, wound-related pain)
- History of trauma to the foot/limb
- History of DFU and infection
- Medications
- Family history of diabetes and DFU.

Other issues such as wellbeing, quality of life and lifestyle factors should also be considered. These may include:

- Employment status/occupation
- General mobility
- Limitations to daily activities
- Psychological and social impact
- Socioeconomic circumstances
- Smoking status
- Nutrition status and weight.

ASSESSMENT FRAMEWORK

In order to make assessment as accurate and thorough as possible, a structured assessment framework should be used. A general wound assessment tool can be used at the first assessment, followed by a specific DFU classification tool (see Classification section below).

The TIMERS assessment framework (Atkin et al, 2019) expands on the original TIME acronym (Dowsett and Ayello, 2004). The TIMERS framework encompasses:

- **T** **Tissue:** type of tissue; non-viable or deficient tissue that requires debridement
- **I** **Infection or inflammation:** high bacterial levels or prolonged inflammation affecting healing
- **M** **Moisture balance:** whether the wound is too wet or too dry
- **E** **Edge of wound:** non-advancing or undermining; including the periwound skin
- **R** **Regeneration/repair of tissue:** how the wound is healing or failing to heal
- **S** **Social factors:** relating to the patient's lifestyle or psychosocial factors.

It was agreed by the expert group that the TIMERS framework provides a useful structured tool that should be used in practice.

DFU CLASSIFICATION

Classification systems are powerful tools for healthcare professionals to use when managing patients with DFUs. The ability to define and stratify the DFU by severity aids communication between providers and allows for a more accurate analysis of outcomes across treatment strategies (Behan et al, 2017). Thus, classification systems are essential for clinical decision-making as well as setting meaningful goals and expectations with patients.

Several classification systems are available when assessing and managing a DFU; see Table 1 for selected classification frameworks.

Table 1. Selected DFU classification frameworks in use

DFU classification system name	Author	Year established	Comments
PEDIS	Lipsky et al/ International Working Group on the Diabetic Foot	2012	Developed by the IDSA, user-friendly (clear definitions, few categories) for practitioners with a lower level of experience with diabetic foot management
SINBAD	Ince et al	2008	Includes site, ischaemia, neuropathy, bacterial infection and depth
University of Texas Wound Classification System	Lavery et al	1996	Validated and generally predictive of outcome, since increasing grades and stages of wounds are less likely to heal without revascularisation or amputation
Wagner Classification System	Wagner	1981	Newer classifications show that the Wagner system does not adequately address all DFUs and infections
WIfI	Mills et al	2014	Merges existing classification systems, including the IDSA classification for diabetic foot infections, into a single concise system

ISDA: Infectious Diseases Society of America; DFU: diabetic foot ulcer

It was agreed by the expert group that the WIfI system is the most appropriate and easiest to use in practice to classify DFUs. The system categorises and grades (0–3) the three major risk factors leading to amputation: wound, ischaemia and foot infection (WIfI); after grading each category, the clinician can clinically stage the affected limb to estimate risk of amputation at one year. Not only does WIfI predict amputation risk, but it is also the only system that can standardise outcome comparisons for accurate analysis of the increasing number of available therapies (Behan et al, 2017).

It should be noted that other classification systems may neglect ischaemia, which is an important element of DFU classification, making the WIfI system ideal for use in practice. However, the WIfI system does not involve a complete vascular assessment, so this may need to be carried out additionally, depending on the patient's presentation and individual needs.

ASSESSING DFU IN A RANGE OF SKIN TONES

DFUs and their associated symptoms may present differently across a range of skin tones. With respect to DFUs, changes in colour may be difficult to spot in patients with dark skin tones, so any changes in colour should be assessed and monitored based on the patient's baseline skin tone. Where possible, the affected foot should be compared to the other foot to compare skin tones, but this may not always be possible in people with diabetes who have had a previous amputation (Dhoonmoon et al, 2021).

Diagnosing infection or ischaemia in people with a DFU and dark skin tones can be challenging due to the lack of colour change and an inability to assess for lymphangitis. Additionally, severe DFUs may present with black or brown eschar overlying the ulcer; in patients with dark skin tones, it is vital to assess the skin thoroughly to ensure that eschar or necrosis is not diagnosed incorrectly or missed (Dhoonmoon et al, 2021).

In people with a DFU, neuropathy may be an issue, which means the patient may not be able to use pain as a sign, making thorough assessment using touch even more important, rather than relying solely on visual assessment. DFUs are at high risk of infection, so any changes should be closely monitored. Extra care should be taken in patients with dark skin tones to ensure that no changes to the foot are missed (Dhoonmoon et al, 2021).

Investigations

DFUs are complex wounds that may require further, and more frequent, investigation, in addition to standard wound assessment and DFU classification. DFUs are known to be prone to harbouring deep infection that may not be easily identified without invasive procedures, such as deep probing or surgery (IWII, 2022).

Additionally, arterial insufficiency and loss of sensation means that up to half of patients may not present with the 'classic' signs and symptoms of infection (Edmonds et al, 2004), which may make infection and other associated complications challenging to identify.

It is important to note that further investigations, such as bone probing or MRI scan by an appropriately trained practitioner, can result in a clinical diagnosis such as osteomyelitis or necrotising fasciitis, where referral and surgical intervention may be required.

WOUND SWABBING

In most clinical settings, wound swabbing is the most frequently used method for collecting pathogenic presence data. This method of sample collection is simple, non-invasive, and relatively inexpensive (IWII, 2022).

Swabbing the wound may be useful where available; however, note that swab culture results may be misleading, as clinical microbiology laboratories are not always suitable for culture of anaerobic species, and may not capture bacteria protected within a biofilm (nor will it detect biofilm), so clinical judgement is also required (IWII, 2022).

Although definitive studies on the optimum method of wound sample collection are lacking, several studies suggest that the Levine technique is a more effective swabbing technique than the Z-swab technique (IWII, 2022).

Where a culture is taken, it is vital that the wound has been thoroughly cleansed and debrided first in order to obtain the most accurate results (Gulf Diabetic Foot Working Group, 2017). It should be noted that tissue biopsy and bone biopsy give a better yield (IWGDF, 2019).

TISSUE BIOPSY

Tissue biopsy is more invasive than swabbing, requires a skilled clinician, and in the absence of peripheral neuropathy, may require local anaesthesia (Travis et al, 2020). However, it has been found that there are significant differences in the pathogens reported from tissue biopsies and swabs, with tissue biopsies isolating more pathogens than swabs. This evidence base has therefore led many expert groups in the area of DFUs to promote the use of tissue biopsy as the gold standard sampling method for detecting the pathogens in infected DFUs (Travis et al, 2020).

A study found that depth of the collected specimen is an important determinant of research utility, and only specimens containing a full-thickness epidermis could be utilized for immunohistochemistry and RNA isolation, which may limit the use of many tissue biopsies in practice (Stojadinovic et al, 2013).

PROBING

Probing may be necessary in DFUs, in order to identify deep infection and potential bone involvement. The International Wound Infection Institute (IWII) recommends the following investigations for DFUs where possible (IWII, 2022):

- Probing to the bone with a sterile metal probe or instrument is an inexpensive, accessible and relatively safe technique (Lipsky et al, 2020) to diagnose diabetic foot osteomyelitis
- Probing to the bone combined with plain X-rays and biomarkers of infection (e.g. ESR, CRP and/or PCT), which can be used to diagnose osteomyelitis in the diabetic foot (Lipsky et al, 2020); it should be noted that, X-rays only show changes to the foot after 2 weeks (Lipsky et al, 2020).

BIOMARKERS

A biological marker (biomarker) is a measurable indicator of a biological state, which may be able to be used to predict wound healing and guide treatment. While testing for biomarkers may not be available in many clinical care settings, advances in genomics, proteomics and molecular pathology have generated many candidate biomarkers with potential clinical value.

Research has identified several cellular events and mediators associated with wound healing that can serve as biomarkers. Macrophages, neutrophils, fibroblasts, and platelets release cytokine molecules including TNF-α, interleukins (ILs) and growth factors, of which platelet-derived growth factor (PDGF) has been found to hold the greatest importance (Patel et al, 2016). As a result, various white blood cells and connective tissue cells release both matrix metalloproteinases (MMPs) and the tissue inhibitors of metalloproteinases (TIMPs).

Studies have demonstrated that IL-1, IL-6, and MMP levels above normal, as well as abnormally high MMP/TIMP ratios are often present in hard-to-heal and non-healing wounds. Clinical examination of wounds for these mediators could help predict which wounds may heal and which may not, suggesting use of these values as biomarkers of wound healing. There is also evidence that the application of growth factors like PDGF may assist the healing process in chronic, hard-to-heal wounds such as DFUs (Patel et al, 2016).

It is known that pH level plays a role in wound healing. In particular, pH has been shown to affect MMP activity, TIMPs activity, fibroblast activity, keratinocyte proliferation, microbial proliferation, and immunological responses in a wound; the patient's defence mechanisms change the local pH of a wound to affect microorganism invasion and proliferation. This pH change has been found to affect the performance of antimicrobials, and therefore the efficacy in biological environments directly relevant to wound healing (Percival et al, 2014).

ISCHAEMIA

Ischaemia (inadequate blood supply) to the foot has important clinical implications for DFUs and may be used to predict risk of healing or amputation. The visual appearance of ischaemia might be indicated by the presence of poor reperfusion to the foot, or black gangrenous toes (Goyal et al, 2020).

Testing the blood supply to the foot via ankle brachial pressure index (ABPI), Doppler testing, ultrasound of blood vessels or other methods of perfusion testing may be particularly useful in DFU care; however, these tests may not be available in all clinical care settings. Computer imaging may also be a useful tool in identifying ischaemia (Goyal et al, 2020).

Computed tomography angiography (CTA) represents one of the most important investigation modalities in the diagnosis and follow-up of vascular diseases, and may be of use in wound care (Mansor et al, 2018).

AUTOFLUORESCENCE IMAGING

Bacterial autofluorescence imaging is a new tool that may be useful in the care of DFUs, as it allows visual representation of bacteria, and therefore can be used to identify infection, predict healing and guide appropriate treatment of DFUs, which are at high risk of infection.

A study using autofluorescence imaging in DFUs found that it was a valuable tool in addition to standard care in DFUs, with the proportion of DFU healing increasing as clinical interventions such as additional debridement could be made when imaging suggested that the wounds were at risk of infection (Rahma et al, 2022).

Focus on infection

Infection is a common complication associated with DFUs. Patients with DFUs have demonstrated increased incidence of hospitalisation due to infection, and infection is commonly the driving force behind amputation (WUWHS, 2016). Patients presenting with severe infection often require emergency surgical intervention. Around 50% of DFUs become infected, and in approximately 20% of these patients, infection will lead to amputation (Wu et al, 2007).

Therefore, it is of paramount importance to identify and treat infection as early as possible. Accurate assessment is crucial to facilitate early intervention and allow clinicians the potential opportunity to curb what is often the progression from simple/mild infection to a more severe problem, which can lead to necrosis, gangrene and ultimately amputation. However, if an accurate assessment is carried out early enough, there may be the opportunity to identify a 'dirty' or high-risk wound before it progresses to worsening infection and extension of tissue damage.

The WIfI classification system (see Classification section, page 7) includes infection as one of its core elements, recognising the need to identify infection at the assessment and classification stage (Mills et al, 2014). Once assessment has been completed, this should trigger appropriate action as soon as possible.

STAGES OF WOUND INFECTION

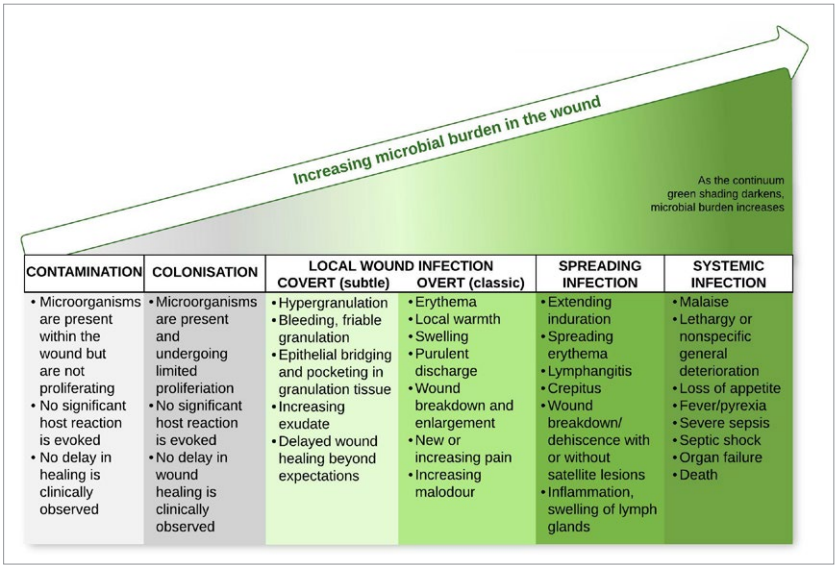
The International Wound Infection Institute (IWII) Wound Infection Continuum (WIC) is a well acknowledged educational tool that provides a framework to conceptualise the impact that microorganisms have on the host, the wound and on wound healing (IWII, 2022).

The IWII-WIC consists of five distinct stages:

- Contamination
- Colonisation
- Local infection (covert and overt stages)
- Spreading infection
- Systemic infection.

See Figure 2 for more information on each stage and its associated signs and symptoms.

FIGURE 2 | The International Wound Infection Institute Wound Infection Continuum (IWII, 2022)



BIOFILM

Currently, there are no easy tests to detect biofilm in a wound, and no tests to show when a wound biofilm is causing a problem. However, we know it is likely that almost all wounds that are slow to heal contain biofilm (Fletcher et al, 2017; Bjarnsholt et al, 2018). If the patient has received appropriate management for a chronic DFU, including its cause and any contributing factors, but the wound remains slow to heal, it is logical to suspect that biofilm is causing healing problems.

Reducing the amount of biofilm in a chronic DFU may tip the balance in favour of healing. If biofilm is suspected in delayed healing of a chronic wound, it should be treated proactively by:

- Repeatedly breaking up and removing the biofilm — through vigorous/active mechanical cleansing and/or debridement
- Reducing biofilm reformation — by decreasing the number of bacteria left in the wound through use of an antimicrobial dressing or topical antiseptic preparation left in place between each session of biofilm removal (Fletcher et al, 2017).

Figure 3 illustrates a proactive approach to biofilm treatment in chronic DFUs where delayed healing may be due to presence of biofilm.

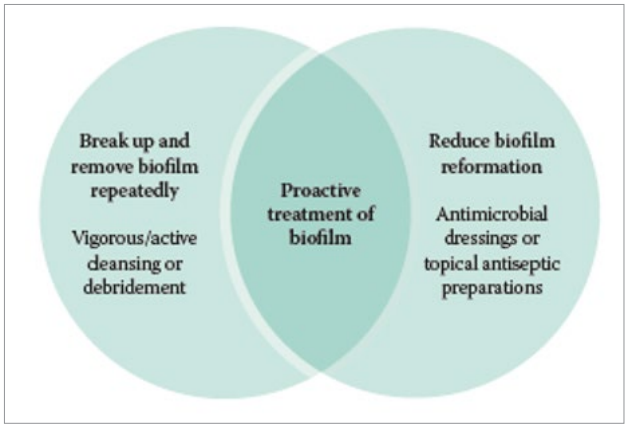


FIGURE 3 | Proactive treatment of a chronic DFU in which delayed healing may be due to biofilm (adapted from Fletcher et al, 2017)

The treatment pathway for DFUs in this document encompasses a biofilm management-proactive approach (see page 15) that includes cleansing and debridement to break up biofilm as well as encourage healing, and infection management and dressing selection that considers the presence of biofilm.

ANTIMICROBIAL STEWARDSHIP

Antimicrobials are a group of agents that either kill or inhibit the growth and division of micro-organisms. This group includes antibiotics, antiseptics, disinfectants and other agents, such as antiviral, antifungal, antibacterial and antiparasitic medicines. Antimicrobial resistance (AMR) describes when micro-organisms evolve over time and no longer respond to any antimicrobial therapy, due largely to overuse or misuse of antibiotics (Fletcher et al, 2020).

The solution to reducing and preventing further AMR is a multimodal approach known as antimicrobial stewardship (AMS). This includes infection prevention and the promotion of judicious use of antimicrobials to preserve their future effectiveness (NICE, 2014; NICE, 2019; PHE, 2019), while also improving the safety and quality of patient care.

In wound care, particularly in high-risk wounds such as DFUs, early identification of infection and infection risk is an integral part of AMS and the reduction of antimicrobial use (Sandy-Hodgetts et al, 2020). AMS programmes generally focus on the following key strategies (Lipsky et al, 2016; Roberts et al, 2017; Stryja et al, 2020):

- To increase efforts towards effective infection control methods and hand hygiene practices
- To create a consistent knowledge base and educational opportunities for clinicians on the effective use of antimicrobials and to reduce variation in practice – thus reducing diagnostic uncertainty, clinical ignorance, ritualistic behaviour, clinical fear, and patient demands
- To prescribe the appropriate antimicrobial treatment when therapy is indicated, minimising unnecessary use of antimicrobials, overly broad-spectrum treatment regimens and the use of antibiotics for non-infected wounds
- To prescribe the appropriate antimicrobial duration, at an optimal dose, administered through the most appropriate route for the indicated condition and patient status
- To use an agent that has the lowest risk of adverse effects.

Figure 4 illustrates the multimodal approach to AMS practices underpinned by education.

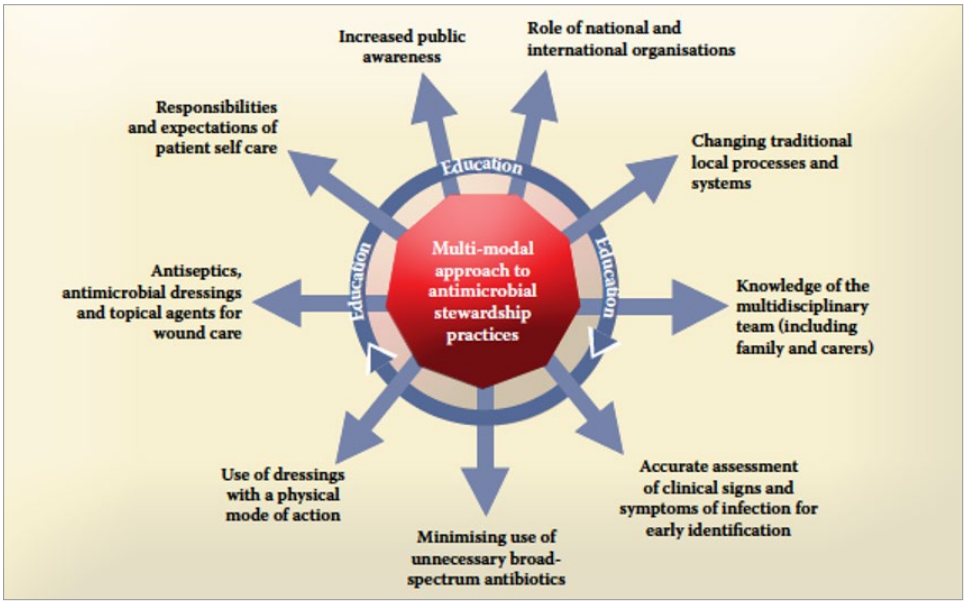


FIGURE 4 | Multimodal approach to antimicrobial stewardship practices underpinned by education (Fletcher et al, 2020)

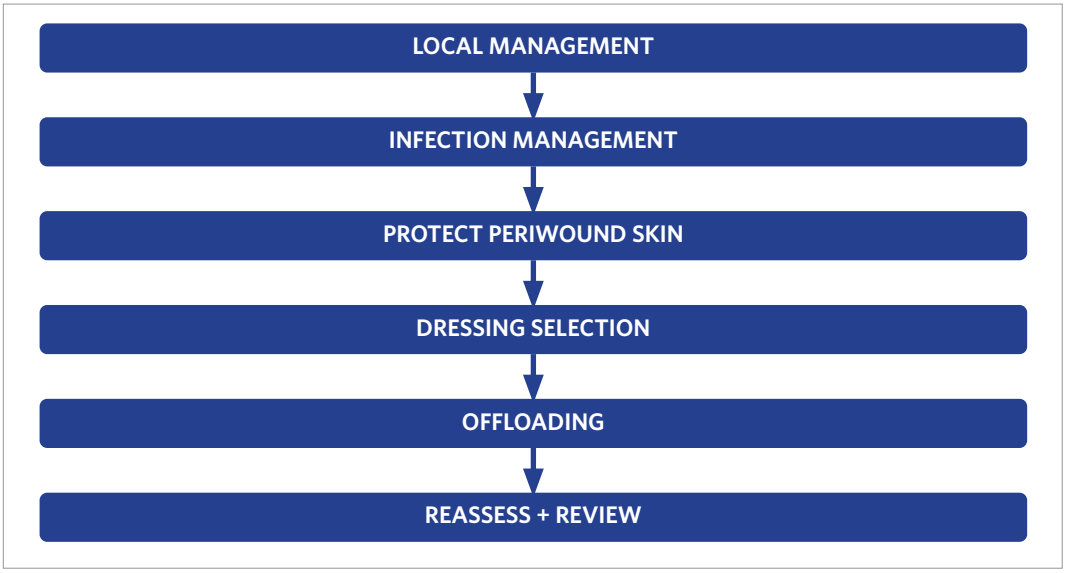
Clinical treatment pathway

Treatment of DFUs should include the following steps:

- Local management (cleansing and debridement)
- Management of infection when needed
- Protect periwound skin from moisture and/or adhesive damage
- Appropriate dressing selection
- Offloading when possible
- Reassessment and review of treatment.

Figure 5 illustrates the appropriate steps of the clinical treatment pathway, with more information on each step in the sections below.

FIGURE 5 | Clinical treatment pathway for DFUs



To aid with clinical decision-making, the TIME Clinical Decision Support Tool (TIMES CDST; Moore et al, 2019) may also be used. The TIME CDST uses an 'ABCD and E' approach to facilitate clinical decision-making:

- Assessment of the patient, wellbeing and wound
- Bringing in a multidisciplinary team
- Controlling and treating the underlying causes and barriers to wound healing
- Deciding on the most appropriate wound treatment to implement and the desired wound management outcome
- Evaluation and reassessment of how the wound is progressing and if the wound management goals have been achieved.

LOCAL MANAGEMENT OF DFUs

Good wound hygiene should be the cornerstone of all treatment (Murphy et al, 2020). The first step in wound treatment for all DFUs should be thorough, routine cleansing, to aid healing and reduce infection risk (WUWHS, 2016). This includes removing all surface debris, slough and infected tissue. DFUs are generally cleansed with water or saline; however, in infected DFUs, a cleansing solution containing an antiseptic agent may be used. If slough is present, gentle rubbing action during cleansing may aid detachment (Murphy et al, 2020).

In deep/cavity wounds where infection is present, negative pressure wound therapy (NPWT) or NPWT with the addition of instillation and dwell time (NPWTi-d). NPWTi-d can be used with saline or antimicrobial agents (only if the wound is infected or the individual is at high risk, in line with antimicrobial stewardship strategies) that have been assessed for device compatibility to reduce the potential for wound infection. The decision as to whether to use standard NPWT or NPWTi-d therapy should be based on the need for wound cleansing or treatment with topical antiseptics (Galea, 2016). Where appropriate to use, NPWTi-d can help to deal with deep and hard-to-heal wounds, contributing to healing time and reduced tissue damage(Gulf Diabetic Foot Working Group, 2017).

Regular debridement is an important aspect of DFU management, aiming to remove slough, non-viable tissue and hyperkeratotic (callused) wound edges. Sharp debridement carried out by experienced clinicians with specialist training is widely used in treatment of DFUs; however, this should be used with caution in a patient with an ischaemic foot (WUWHS, 2016). In cases of ischaemia, the patient should be referred in a timely manner to a vascular surgeon before extensive tissue loss occurs.

Surgical debridement may be considered where necessary (e.g. for large areas where rapid removal is required). This must be carried out by a surgeon skilled and experienced in managing DFUs and foot infections (Gray et al, 2011). Surgical reconstruction options vary depending on DFU type and severity and are complex, involving internal and external fixation devices including pins, compression screws, staples, and wires for both repair and stabilisation (Varma, 2011). Surgical debridement aims to reduce pain, restore function, stability, and proper appearance of feet to avoid limb loss, dependency, and lowered quality of life.

Autolytic debridement should also be considered as a management option for both removal of devitalised tissues and to inhibit the continuing collection of layers of wound debris. While this technique may require more time than surgical or sharp debridement, it allows for a more selective removal process, which results in the retention of larger quantities of viable tissue.

Documentation and continued monitoring of the patient as treatment continues is key. If the wound is not improving, treatment should be reassessed, and other strategies considered. Monitoring the wound's size is important, as this is an indicator of progress and will also help to identify any other potential problems that may lead to the DFU becoming chronic and being at further risk of complications. Depending on the patient's individual needs, advanced or specialist treatments such as topical oxygen or topical haemoglobin spray may also be used to improve oxygenation to the wound and encourage healing (Kaufman et al, 2021).

Depending on the patient's overall health and clinical needs, surgical intervention may be needed. This will depend on the clinician's judgement and based on testing such as Doppler or CTA. In some cases, intervention may be needed to help close the wound (i.e. skin grafting).

INFECTION MANAGEMENT

In line with AMS principles (see page 14), local/topical antimicrobial treatment should be used whenever possible in DFUs that are infected or at a high risk of infection. If infection is severe/systemic, systemic antibiotic treatment may be necessary (see Figure 2 for the infection continuum). Management of infection or infection risk may also be addressed through appropriate dressing selection (see page 17).

If infection is allowed to progress and becomes severe/systemic, the patient is at risk of sepsis, which is a rare but potentially fatal condition (Fletcher et al, 2020). Recognising and treating infection early, before sepsis develops, is vital. If the patient has signs or symptoms of severe infection and appears ill, then care should be escalated immediately.

Patients and their carers and families should be made aware of the symptoms of sepsis so they can seek urgent medical attention (Box 2). In the case of sepsis, urgent action includes immediate, high-level resuscitation with fluids, oxygen and systemic antibiotic therapy (IWII, 2022).

Box 2. Symptoms of sepsis

Escalate care and/or seek urgent medical help if the patient develops any of these signs:

- Slurred speech or confusion
- Extreme shivering or muscle pain
- Passing no urine (in a day)
- Severe breathlessness
- Is feeling like he/she is going to die
- Skin mottled or discoloured
- Uncontrollable hyperglycaemia.

PERIWOUND PROTECTION

Diabetes is a risk factor for potential periwound skin complications, and steps should be implemented to help prevent skin damage to periwound skin from moisture and/or adhesive dressings. Using a skin protectant (e.g. protective barrier film, polymer-cyanoacrylate system) may reduce the risk of skin damage (LeBlanc et al, 2021).

DRESSING SELECTION

Dressing selection for DFUs requires a multifactorial approach that takes all aspects of the wound into consideration (WUWHS, 2016). Using the appropriate dressing in DFUs should address basic and advanced tissue requirements, including infection or infection risk. It is important to remember that dressing selection should be led by evidence-based medical practice wherever possible.

The factors that must be evaluated when selecting a dressing include (Gulf Diabetic Foot Working Group, 2017):

- Moisture/exudate management: the dressing needs to be able to handle high levels of exudate if necessary, taking into account both volume and type/viscosity of the exudate (which may particularly be an issue in infected wounds, as they may have a high level of thick, purulent or thin, serous exudate); equally, in dry wounds, it is important to encourage a moist wound environment to optimise healing
- Depth: in deep DFUs, packing may be required to eliminate dead space and to retain proximity of active dressings within irregular wound dimensions; in deep wounds and excessively large wounds, advanced therapies such as negative pressure wound therapy (NPWT) may be considered
- Protection: the dressing needs to be appropriate for use with offloading devices/footwear solutions as required
- Management of devitalised tissues: when necessary, dressing selection should include those with the properties and/or capabilities to prevent, minimise or remove devitalised tissues from the wound bed, and be available in hospital settings and/or in the community.

Dressings incorporating antimicrobial agents may be used in infected DFUs, in line with AMS principles for topical treatment where appropriate. Frequently used topical antimicrobial agents include iodine or silver-impregnated dressings, or dressings incorporating PHMB (polyhexamethylene biguanide) or octenidine. Specialty dressings containing surfactants possess the ability to provide continuous wound and periwound cleansing and can be found with the addition of antimicrobial silver to optimise bioburden and odour control. Charcoal dressings may be considered to deal with malodour where needed. Charcoal dressings may be considered to address malodour. For an overview of dressings that are available for use in DFUs, see Table 2.

If after 2 weeks no improvement is seen, the antimicrobial agent in use should be discontinued and an alternative considered (Gulf Diabetic Foot Working Group, 2017). This is referred to as the principle of the two-week challenge.

Table 2. Overview of wound dressings available for use in DFUs (adapted from Wounds International 2013)

Type	Actions	Indications/use	Precautions/contraindications
Alginates/CMC*	Absorb fluid Promote autolytic debridement Moisture control Conformability to wound bed	Moderate to high exuding wounds Special cavity presentations in the form of rope or ribbon Combined presentation with silver for antimicrobial activity	Do not use on dry/necrotic wounds Use with caution on friable tissue (may cause bleeding) Do not pack cavity wounds tightly
Foams	Absorb fluid Moisture control Conformability to wound bed	Moderate to high exuding wounds Special cavity presentations in the form of strips or ribbon Low adherent versions available for patients with fragile skin Combined presentation with silver or PHMB for antimicrobial activity	Do not use on dry/necrotic wounds or those with minimal exudate
Honey	Rehydrate wound bed Promote autolytic debridement Antimicrobial action	Sloughy, low to moderate exuding wounds Critically colonised wounds or clinical signs of infection	May cause 'drawing' pain (osmotic effect) Known sensitivity
Hydrocolloids	Absorb fluid Promote autolytic debridement	Clean, low to moderate exuding wounds Combined presentation with silver for antimicrobial activity	Do not use on dry/necrotic wounds or high exuding wounds May encourage overgranulation May cause maceration
Hydrogels	Rehydrate wound bed Moisture control Promote autolytic debridement Cooling	Dry/low to moderate exuding wounds Combined presentation with silver for antimicrobial activity	Do not use on highly exuding wounds or where anaerobic infection is suspected May cause maceration
Iodine	Antimicrobial action	Critically colonised wounds or clinical signs of infection Low to high exuding wounds	Do not use on dry necrotic tissue Known sensitivity to iodine Short-term use recommended (risk of systemic absorption)
Low-adherent wound contact layer (silicone)	Protect new tissue growth Atraumatic to periwound skin Conformable to body contours	Low to high exuding wounds Use as contact layer on superficial low exuding wounds	May dry out if left in place for too long Known sensitivity to silicone
Polyhexamethyl-ene biguanide	Antimicrobial action	Low to high exuding wounds Critically colonised wounds or clinical signs of infection May require secondary dressing	Do not use on dry/necrotic wounds Known sensitivity

Table 2. Overview of wound dressings available for use in DFUs (adapted from Wounds International 2013) (Continued)			
Type	**Actions**	**Indications/use**	**Precautions/contraindications**
Polymeric membrane	Absorb, moisturise, active debridement, cleanse, non-narcotic pain control, protect	Dry to highly exudative wounds, superficial, deep cavity, tunnels and undermining; silver option for antimicrobial activity, colonised to actively infected	Do not use silver dressings on patients with sensitivity to silver
Odour control (eg activated charcoal)	Odour absorption	Malodorous wounds (due to excess exudate) May require antimicrobial if due to increased bioburden	Do not use on dry wounds
Protease modulating	Active or passive control of wound protease levels	Clean wounds that are not progressing despite correction of underlying causes, exclusion of infection and optimal wound care	Do not use on dry wounds or those with leathery eschar
Silver	Antimicrobial action	Critically colonised wounds or clinical signs of infection Low to high exuding wounds Combined presentation with foam and alginates/CMC for increased absorbency. Also in paste form	Some may cause discolouration Known sensitivity Discontinue after 2 weeks if no improvement and re-evaluate

Dressing change frequency should be minimised as much as possible for non-infected wounds to encourage undisturbed wound healing (UWH) and reduce the potential for external contamination and transient episodes of hypothermia. Clinicians should be aware that DFUs can deteriorate quickly and should be closely monitored. Where infection is present, the wound should be monitored frequently (as often as every 1–2 days if possible). This is particularly important if there are signs of systemic infection.

Despite the frequency of sensory neuropathy, many patients experience pain during dressing changes due to episodes of secondary mechanical hyperalgesia. Pain can be minimised by paying close attention to technique and using non-adherent, easy-to-remove dressings. It is important to note that newly occurring pain may be due to infection. See Box 3 for more information on pain management in DFUs.

The potential for pain should be acknowledged in all patients before performing potentially painful procedures such as sharp debridement and dressing change. Appropriate pain relief such as analgesia should be offered to all patients, according to the World Health Organization

Box 3. Pain management in DFUs

It is often assumed that neuropathic pain is the only type of pain experienced by patients with DFUs, except as a symptom of complications such as infection, Charcot arthropathy or osteomyelitis. However, there still appears to be no evidence to suggest that patients with DFUs do not experience nociceptive pain, procedural pain or other experiences of non-cyclic or cyclic acute pain as described by Krasner's Chronic Wound Pain Model (Krasner, 1995). In fact, it has been shown that specific ulcer pain from DFUs can occur despite the presence of sensory peripheral neuropathy (Bradbury and Price, 2011)

analgesic ladder (WHO, 2022). It is important to remember that DFU pain can negatively impact the patient's quality of life both physically and psychosocially, similar to pain from other wound aetiologies.

OFFLOADING

Offloading is considered an important element of DFU care. The International Working Group on the Diabetic Foot (IWGDF) states, "Offloading is arguably the most important of multiple interventions needed to heal a neuropathic plantar foot ulcer in a person with diabetes" (IWGDF, 2019). Once a DFU has developed, healing will be chronically delayed if the area is not effectively offloaded (IWGDF, 2019).

However, in many areas within the APAC region, access to offloading techniques and devices is not readily available and podiatrists are not available to work within the MDT. There may also be issues with cost and availability of offloading devices. This represents a gap in care and a significant challenge in DFU care in the APAC region.

REASSESSMENT AND REVIEW OF TREATMENT

Documentation and continued monitoring of the patient as treatment continues are key. DFUs should be monitored closely for development of worsening infection, and should be evaluated on a weekly basis if possible (Gulf Diabetic Foot Working Group, 2017).

If access to a clinician is an issue (e.g. if the client is in a rural area, or access to a hospital/clinic is prohibitive), use of telemedicine or remote care using video or photography of the wound may be an option (see page 22 for more information).

If the wound is not improving, treatment should be reassessed and other strategies considered. Monitoring the size of a wound is crucial, as this is an indicator of progress and will also help to identify other potential problems that may lead to chronicity. After 4 weeks, the wound size should have reduced by at least 50% or treatment should be reviewed, with a full reassessment of the patient, their health and their wound (Gulf Diabetic Foot Working Group, 2017).

It may be necessary to monitor the patient's overall health, particularly regarding glycaemic control in patients with DFUs. Evidence has suggested that elevated A1C levels (U8%) and fasting glucose levels (U126mg/dl) are associated with increased likelihood of amputation in patients with DFUs (Lane et al, 2020).

Improving outcomes

The overall aim of the treatment pathway for all DFU care, is to improve outcomes for patients. This may include both primary and secondary outcomes; whereas the primary outcome for the majority of DFUs is wound closure, for wounds that are not predicted to heal, the focus will be on secondary outcomes such as patient quality of life. Objectives of treatment may include factors such as: wound healing, improved quality of life, reduced costs, reduced incidence of adverse events, reduced resource use, improved pain levels, reduction in wound infection, and reduction in mortality (Liu et al, 2017).

Aims of treatment should be agreed in collaboration with the patient, to make sure that treatment suits the patient's lifestyle and personal circumstances, and so the patient will get the most out of their treatment (WUWHS, 2020a).

MULTI-DISCIPLINARY TEAM APPROACH

The MDT is composed of healthcare workers who are members of different medical and surgical disciplines (e.g. nurses, surgeons, diabetologists, vascular specialists, endocrinologists, other healthcare professionals), each providing specific services to the patient. An MDT approach aims to coordinate services as a team, to work together towards specific goals to optimise care and outcomes for the patient.

An MDT approach is particularly important in DFU care, as DFUs are a manifestation of a complex condition that affects many aspects of the patient's health and overall wellbeing. Communication between healthcare professionals is important in improving outcomes and ensuring the patient receives the best care possible (Edmonds, 2008; WUWHS, 2020a).

A study from Thailand found that an MDT can reduce both major and minor amputation compared with standard care where each physician treats diabetic foot mainly on their own territory (Rerkasem et al, 2007; Rerkasem et al, 2008). This study also showed that the MDT improve quality of life (physical and emotional aspect) and saved cost, compared with standard practice (Rerkasem et al, 2009).

PATIENT-CENTRED CARE

Patient-centred care—focusing on the individual, their health and their needs—is vital. To be effective, care must be tailored to the patient's individual intellectual capacity, health, lifestyle, and overall circumstances.

Patient advocacy is an important element of care: it is part of the healthcare professional's role to listen to the patient and consider their individual needs. This means understanding and considering the patient's choices, needs and preferences, and helping to advocate for these in practice and within the healthcare team. This may be particularly relevant in vulnerable patients who are not able to advocate for themselves due to factors such as illness, mental capacity or social position (Nursing Times, 2017).

Patients have the right to be involved and informed about their own care; it is important for them to be aware they have the right to ask questions and make comments. The healthcare professional should help to encourage an environment where the patient feels safe, supported, and able to speak up (WUWHS, 2020a).

SELF-CARE

Wherever possible, self-care can form an important part of a patient's treatment plan. Engaging in self-care can help the patient to be more educated about their own treatment and feel empowered, helping them to engage more meaningfully with their own care (WUWHS, 2020a).

Depending on the patient's circumstances and geographical location, self-care may be vital to ensure that the patient's DFU is cared for; for example, for patients who live in rural areas without ready access to healthcare professionals, being educated in how to care properly for their own DFU may be vital to ensure their wound does not deteriorate or develop infection or other complications. In some areas, hospital care may be prohibitive, and DFUs can be slow to heal, so it is not feasible for the patient to remain in a care setting for the healing period.

Patients should be educated in their own care and be aware of 'red flags', such as signs and symptoms of infection that indicate when care needs to be escalated or they need to contact their healthcare professional (Box 4).

Box 4. Red flags for patients with diabetes

Escalate care and/or seek urgent medical help if any of the following develop:

- Unexplained red, hot or swollen foot with, or without, pain
- Changes in colour and/or shape of feet
- Loss of feeling in feet or legs
- Tingling sensation or pins and needles
- Blisters, cuts, sores, or wounds that don't heal

However, while self-care is key, it should always be considered as part of a wider, structured support system wherever possible. It is important that self-care is conducted in collaboration with healthcare professionals and that guidance is available when needed, to minimise the likelihood of patients being 'lost' and failing to receive the care they need (WUWHS, 2020a).

Furthermore, it is important to consider the patient's capacity and willingness to be involved in their own care. Establishing the patient's ability to be involved in their own care, and their capacity for understanding and education, are key to successful self-care strategies (WUWHS, 2020a).

TELEMEDICINE

Depending on the patient's circumstances and resources, telemedicine can be a useful option for monitoring and providing treatment. It may be particularly useful for patients in rural areas or who do not have easy access to seeing a healthcare professional in person. The popularity of the internet and smart devices, such as mobile phones and tablets, has made it possible to adopt telemedicine to improve the management of chronic wounds such as DFUs, where it would not previously have been possible. Increases in use of telemedicine during the COVID-19 pandemic have shown it can play an important role in healthcare.

While there may be conflicting views on the efficacy of telemedicine versus in-person treatment, currently available evidence suggests that telemedicine seems to have similar efficacy and safety and has met noninferiority criteria versus conventional standard care of chronic wounds (Chen et al, 2020).

As well as monitoring the patient via telemedicine, it may be useful to encourage patients

to monitor their own wound via photographs and taking notes or keeping a wound journal (WUWHS, 2020a).

CAREGIVERS

As well as the patient, it is important to consider relatives or other caregivers who will be involved with the patient's treatment and wellbeing. Where relevant, family and carer involvement should be considered as a part of the MDT approach, with all stakeholders as involved and informed as possible (WUWHS, 2020a).

Both the patient and their carers should be educated as much as possible about the DFU, the treatment plan and how to contact the healthcare professional if necessary. Family and carers, as well as the patient, may need to be educated about ongoing elements of care such as dressing changes or skin care, as well as 'red flags' that require action.

The future

With diabetes and DFU rates rising rapidly in the APAC region, education and raising awareness are of key importance. Education is required in the following ways:

- For clinicians—to increase their confidence and competence in managing DFUs and providing the best options for patients to improve outcomes
- For patients—to increase awareness of DFU prevention and to facilitate effective self-care
- For carers/relatives of patients—to ensure that patients receive appropriate care, even when access to a clinical setting is not possible, or to know when to contact a clinician if 'red flags' arise, or further care is required.

Developments in telemedicine may help many patients to receive the care they need, particularly if they are in rural areas where access to clinicians or a clinical setting is not easily available.

Advances in technology are aiding in the identification of DFUs and potential infection and thus facilitating early intervention, which may help to improve outcomes.

It is vital to keep the patient at the centre of care in all clinical settings, and to tailor treatment to the patient's individual health, needs and preferences.

The ultimate aim is to optimise DFU prevention and management to improve outcomes and patients' quality of life as much as possible, given this serious and growing issue.

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