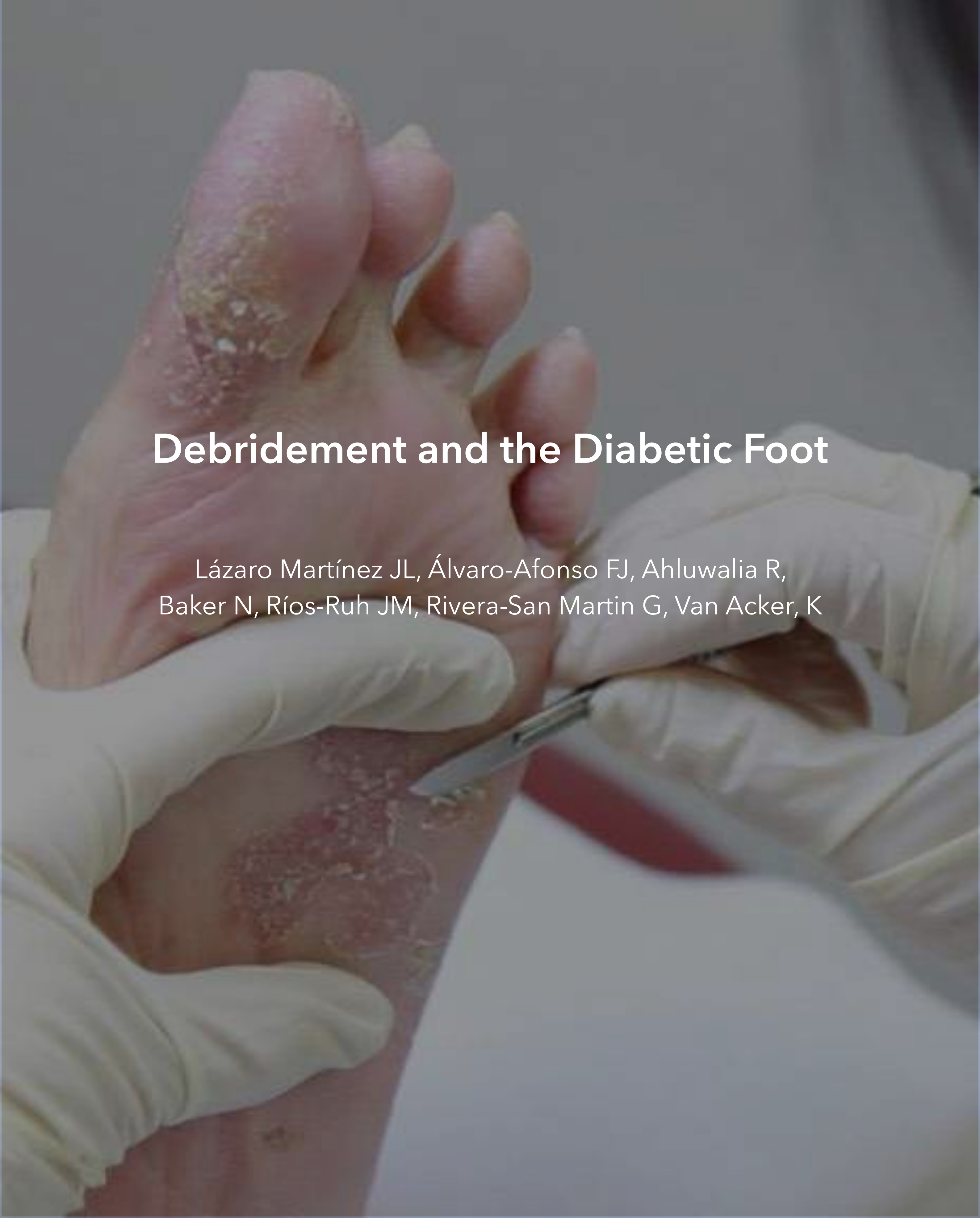

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D-FOOT international

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Abstract

Debridement is part of the standard of care for diabetic foot ulcers. There are several methods (sharp/surgical, biological, autolytic, biochemical and osmotic) but not a lot of evidence to support choosing one method over another. New foot ulcer therapies and technology appear regularly, but most are too expensive or difficult to implement in most high-need areas. All of these factors make it very difficult for healthcare professionals to choose the optimal debridement method for their patients.

The following article looks at the various debridement methods from a clinical perspective, outlining the advantages and disadvantages of each in the context of daily practice. Our aim is to give healthcare practitioners some sound data to help them make best possible treatment decisions wherever they are practicing.

President's note: *We wrote this article primarily for healthcare providers working in remote areas, where 80% of all diabetic foot disease is found. With that in mind, we have tried to use plain language to make the content as broadly useful as possible.*

Debridement and the Diabetic Foot

Managing diabetic foot ulcers is a complex business requiring knowledge of care standards in several medical specialties. When deciding on a treatment plan, practitioners must take into account comorbidities like cardiac or kidney disease, manage the patient's metabolic status, maximize blood flow to the foot, deal with any infection and offload.

One of the best and simplest ways to effectively control infection is to remove the contaminated or dead tissue from around a wound using one of the seven debridement techniques. When healthy, clean tissue is exposed, pus, blood and other fluid can drain fully, allowing the healing cascade process to begin more quickly. The practitioner can also swab the ulcer to determine the cause of the infection (Edmonds et al.[1])

The benefits of ulcer debridement are clear, but there has been some confusion as to the best method (Game et al.[2]). Current diabetic foot ulcer training concentrates mainly on sharp or surgical debridement, largely because it is the fastest method of preparing the wound bed. Speed is a compelling factor, but not the only important one. When co-morbidities, vascular status, level of infection, location of the ulcer and patient preference are also be taken into consideration, practitioners may find another debridement method works better either as the primary treatment option or in tandem with options over time. In some situations, like early-onset ischemia, sharp or mechanical debridement is not just sub-optimal, it's a bad idea.

Table 1

Parameters for assessing before making a decision to select a debridement technique

Health Professional Parameters	Patient Parameters	Ulcer Parameters
Professional's skill and training	Patient environment	Speed required to remove non-viable tissue
Resources and facilities	Co-morbidities (i.e. renal failure, cardiovascular status, coagulation status) Vascular status of the affected limb	Presence of bio-film or level of bioburden of the ulcer Characteristics of the non-viable tissue at the wound bed
Regulations	Quality of life & expectations	Status and presence of non-viable tissue at the wound edges and peri-wound skin
Guidelines (European, national)	Patient choice and consent	Depth and location of non-viable tissue and percentage of the wound bed
Cost	Pain	Level of exudates

There are three types of diabetic foot ulcers, neuropathic, neuro-ischemic or ischemic. Given that half of all people with diabetes in America and Europe now experience peripheral vascular disease, neuro-ischemic ulcers now account for more than half of all foot ulcers in these regions.

The point of debridement is to remove dead or diseased tissue and reduce the bio-burden safely. While debridement is a quick and relatively easy treatment to administer, it is not permanent. Patients often need additional debridement with each dressing change or for the wound bed to become sub-optimal by the next visit. Though sharp/surgical debridement is the preferred method due to its immediate results, other methods are also valid treatment choices. For example, in areas where district nurses are not permitted to carry out sharp debridement, products that use microfibres instead of a blade to remove debris around the wound are popular. It is simple,

Table 2

Methods of debridement and categories

Method of Debridement	Category
Physical/Mechanical	Surgical, Sharp, Wet-to-Dry Hydro-surgery Microfibre pads Ultrasound debridement
Biological	Larval therapy
Autolytic	Hydrogels, Hydrocolloids, Alginates, Hydrofibers
Biochemical (enzymatic)	Collagenase, Streptokinase Fibrinolysin, Papain Desoxyribonuclease, Polysaccharide beads or paste dextranomer polysaccharide
Osmotic	Honey

cheap, relatively painless and requires no special training to administer, which makes it a good choice for at-home maintenance treatments after the initial sharp debridement.

Understanding the differences between the debridement techniques (sharp/surgical, biological, autolytic, biochemical and osmotic) and how they help control bio-burdens and stimulate healing is vital for health care practitioners treating diabetic foot ulcers.

Autolytic debridement

Autolytic debridement is a natural process in which endogenous proteolytic enzymes, commonly known as hydrogels, dissolve sloughy, necrotic and diseased tissue. Proteolytic enzymes include collagenase, elastase, myeloperoxidase, acid hydroxylase or lysozymes and are aided in their work by the activation of phagocytes. Dressings containing hydrogels cause necrotic tissue to swell and detach.

A recent Cochrane review concluded that wounds wrapped in hydrogel dressings healed faster than plain gauze or standard of care dressings (Game et al.[2]).

Figure 1
Use of a hydrogel in a diabetic foot ulcer

If a wound is weeping or infected, a better choice is hydrogel with alginates or hydrofibres. These are much more absorbent than regular hydrogels and trap micro-organisms, giving the dressing antibacterial and antifungal properties.

Advantages – safe, easy to use, can be applied anywhere by anyone and doesn't damage healthy tissue.

Disadvantages – doesn't work well on weight-bearing areas of the foot, fistulae or wounds that are bleeding, ischemic, or necrotic, unsuitable for wounds that are very wet or infected. Hydrogels work slower than other methods and don't always remove all the non-viable tissue.

Biochemical/enzymatic debridement

Figure 2
Use of collagenase in a patient with a neuro-ischaemic diabetic foot ulcer

Biochemical debridement agents contain proteolytic enzymes and work with endogenous enzymes to degrade fibrin and denaturalize collagen and elastin. The enzymes disrupt all types of collagen while maintaining the integrity of viable tissue. They also allow the development of granulation tissue and subsequent epithelialization of dermal ulcers.

In a recent study (Tallis et al.[3]), biochemical debridement with Clostridial collagenase ointment resulted in a statistically significant decrease in wound area over 12 weeks as compared to saline-moistened gauze and selective sharp debridement. A recent systematic review with meta-analysis (Patry et al.[4]) supported the use of collagenase in diabetic foot ulcers, although concern was raised regarding a high risk of bias. Other enzyme debridement methods, such as polysaccharide beads have not been evaluated for treating diabetic foot ulcers. Collagenase needs a moist environment to be effective.

Advantages – safe, easy to use, can be applied anywhere by anyone. This type of debridement can be useful for mild neuro-ischemic ulcers, in patients with bleeding problems and if surgical debridement is contraindicated.

Disadvantages – ointment can irritate the skin around the wound, antiseptic and soap interfere with the enzyme action and should be avoided, doesn't work very quickly, though faster than autolytic debridement, contraindicated for ischemic ulcers.

Figure 3
Use of maggot debridement therapy

Biological debridement (Larval Therapy)

Larval therapy, also known as maggot debridement therapy (MDT), has been used to debride wounds for more than 400 years. Live maggots (Lucilia sericata) are set on the ulcer, either loose or inside a polyvinylalcohol net dressing (biobag) and facilitate healing through a kind of holistic wound bed preparation. New maggots must be introduced every 3-5 days, but usually only 2-3 applications are necessary.

While the maggots eat necrotic and non-viable tissue, they secrete an antibacterial compound that reduces the bio-burden as well as facilitating remodelling, reducing inflammation and increasing neo-angiogenesis.

Larval therapy has been studied as a treatment for pressure ulcers and venous leg ulcers, but not much research has been done in the area of diabetic foot ulcers. Patients with critical limb ischemia (CLI) who were treated with maggots experience greater healing rates than those who received conventional treatment (Nishijima et al.[5]). Maggots are best suited for neuro-ischemic and ischemic diabetic ulcers, when sharp/surgical debridement is contraindicated or when other debridement methods (autolytic or biochemical) have failed. Biological debridement is adjuvant treatment option for CLI patients after revascularization.

Advantages – can be applied anywhere, reduces the bio burden and promotes wound healing faster than sharp/surgical debridement, treatment is finished in as little as 2-3 weeks.

Disadvantages – patients may resist having maggots on their body, sometimes maggots do their job too well and drown the wound in secretions, though usually just in the first 24-48 hours, patients must also remain immobile to avoid crushing the maggots, treatment can be costly and skill in application is needed, particularly if the free range method is used.

Figure 3
Application of osmotic debridement by honey in diabetic foot ulcers

Osmotic Debridement/Honey

Honey, the oldest form of debridement, works by drawing fluid from surrounding healthy tissue to accelerate autolytic debridement. Preparations come in several forms: sheets, gels and pastes and some with alginate fibres. The honey reduces the wound pH (3-4.5), a byproduct of which is the releasing of hydrogen peroxide or methylglyoxal. This pH reduction creates an acidic environment hostile to bacteria and other pathogens. Some studies found that honey performed only as well as a placebo (Slavash et al.[6]).

Advantages – reduces bioburden, can be applied by anyone, anywhere.

Disadvantages – some studies found honey performed only as well as a placebo, over-treatment can result in over-drying a neuro-ischemic or ischemic ulcer, treatment can be costly because it requires many applications over several months.

Sharp/Surgical Debridement

Sharp/surgical debridement is a fundamental part of standard diabetic foot ulcer management. There are two approaches: sharp debridement (fig. 4), which is done with scissors or a scalpel and without anaesthetic. and surgical debridement, which is done with local or general anaesthesia . In both cases, infected or dead tissue is cut back until healthy, bleeding edges are revealed. Practitioners can explore fistulas, open deep cavities and assess the true dimensions of major ulcers. Sharp/surgical debridement also allows tissue sampling and biospies for microbiology and histopathology. This is particularly important when managing chronic non-healing wounds.

Figure 4
Sharp debridement in a patient with diabetic foot ulcer and Charcot foot

Infection can spread alarmingly fast, result in extensive tissue loss and bone infections and even compartment syndrome. Radiological images can help identify gas in deep tissues as well as abscesses in necrotizing soft tissue infections. In these cases, practitioner must work together immediately with a multidisciplinary team as describe in the FOOT ATTACK models of care. Because of the urgent nature of the situation, surgical debridement is the only effective treatment. When ischemia is present, liaison with vascular surgeons is imperative. Proper wound drainage and tissue compression followed by rapid vascular intervention is essential to prevent the spread of sepsis.

Figure 5
Surgical debridement in diabetic foot ulcers

Calluses or hyperkeratosis are often present at the edge of neuropathic diabetic foot ulcers and may apply undue pressure to the margins. Sharp debridement to remove this tissue facilitates the contraction of the surrounding skin and reduce the risk of infection.

Like all debridement options, sharp/surgical debridement is rarely a one-off solution. With each wound dressing change, newly sloughing or necrotic tissue needs to be cut away.

Advantages – extremely fast compared other methods, all non-viable tissue is removed, risk of infection is greatly reduced, impediments to new tissue growth removed, relatively cheap, can be carried out in poor and developing countries with minimal training.

Disadvantages – requires a skilled practitioner, patient needs to be in good vascular health, recommended only for advanced neuro-ischemic ulcers, usually requires anaesthetic and other surgical tools, patients may not want to be cut or have co-morbidities that rule this method out.

Hydrosurgery

Hydrosurgery is a mechanical method of debridement in which practitioners use a high-pressure sterile saline (0.9%) jet to remove necrotic tissue and debris. A vacuum is placed around the wound to removed pus, blood and other fluids and improve aspiration. The location, depth and size of the wound determines the water pressure needed and angle of application, both of which can be adjusted in real time via foot pedal.

Advantages – faster than sharp/surgical debridement and results in a more homogenous wound bed.

Disadvantages – expensive and requires specialist equipment, can cause bleeding and is uncomfortable for the patient.

Ultrasound-assisted Debridement

Very similar to hydrosurgery except ultrasound assisted debridement uses a low-frequency ultrasound (25Khz and 35-40W/cm^2) along with the water to disrupt the biofilm and remove dead tissue. The low frequency means tissue doesn't heat up during treatment, a significant cause of patient discomfort.

Cavitation, that is to say, the bubbles the ultrasound makes in the water, are able to penetrate deeply into all parts of the wound cavity, disrupting and washing out the biofilm. A randomized controlled trial published by Herberger et al [8] found that treatment with an ultrasound-assisted wound debridement (UAWD)[7] tool healed as well as good as sharp/surgical debridement. (Figures 6a and 6b).

Advantages – effective, simple, relatively pain-free, can be done anywhere and is more tissue-selective than sharp/surgical debridement.

Disadvantages – specialist equipment required, some concerns about infection control due to vapour spray, though these have yet to be substantiated.

Figures 6a and 6b
Neuroischemic diabetic foot ulcer after 6 weeks of Ultrasound-Assisted Wound Debridement therapy.

Summary

It is clear that debridement is an essential part of foot ulcer management. What's more complicated is the criteria for choosing one method of treatment over another. Most of the already published RCTs about debridement look at wound dressing products, so there is little material available for practitioners wanting to make an evidence-based decision. For some cases, time is the most important factor, for others, particularly those is low-to-middle income regions it may be equipment availability or available practitioner skill. Since even the most advanced clinic will encounter patients with different needs, adaptability is the main requirement for successful patient care.

Table 3

Summary of recommendations for selecting a technique of debridement. For ischemic DFUs restoring vascular status by Vascular Surgeon's team is mandatory prior to debride the ulcer except in cases of infection threating the limb or the life of the patient.
UAWD = Ultrasound Assisted Wound Debridement.

	First Recommendation	Alternatives
Neuropathic Diabetic Foot Ulcer with: - Non-viable tissue - Necrosis - Abscess - Necrotizing Soft Tissue infections - Soft tissue infections - Bone infections (when is needed)	Surgical	Hydrosurgery UAWD Hydrogels Alginates Hydrofyber Honey
Neuroischemic Diabetic Foot Ulcer with: - Necrosis - Abscess - Necrotizing soft tissue infections - Soft tissue infections - Bone infections (when needed)	Surgical	UAWD Enzymatic Larval Therapy Honey
Calluses and hyperkeratosis in the surrounding skin	Sharp debridement	Off-loading for prevent new formation of callus
Slough tissue in neuroischemic DFUs	UAWD	Enzymatic Larval
Neuroischemic DFUs beneath risk areas to expose: joint capsule, bone or tendon	UAWD	Larval
Management of bacterial load	UAWD	Larval Honey

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