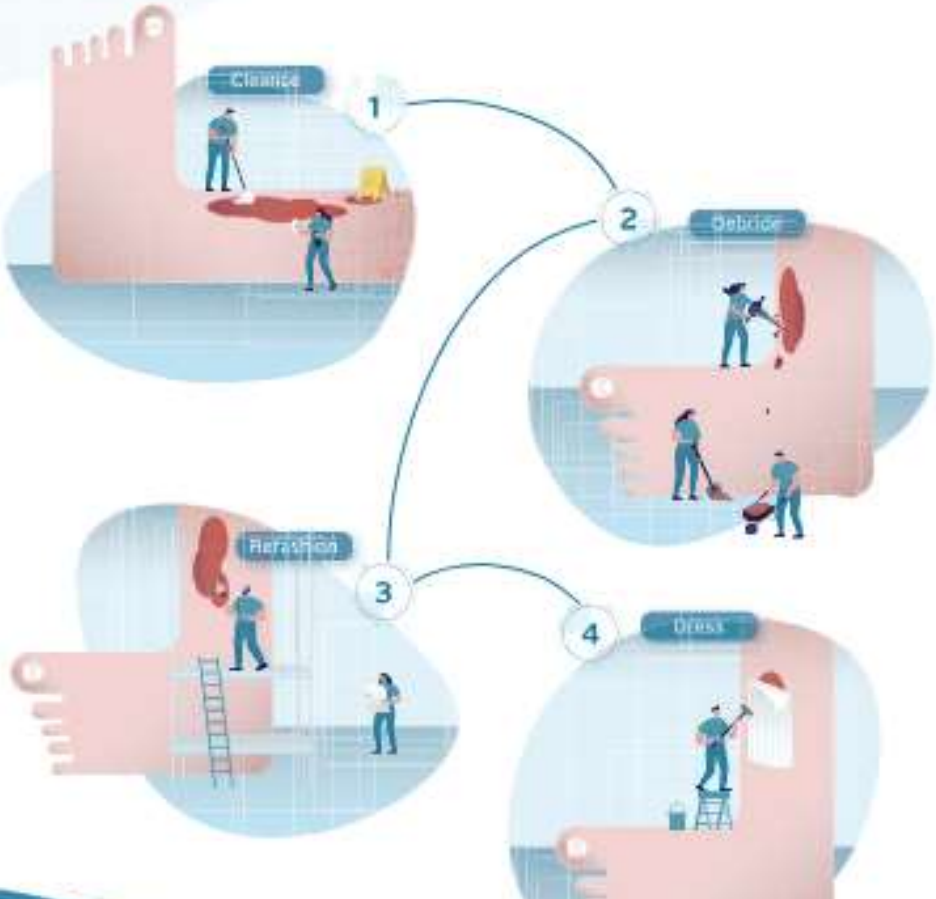
JWC International Consensus Document

Defying **hard-to-heal wounds** with an early antibiofilm intervention strategy: **wound hygiene**



Authors:

- **Christine Murphy**, PhD, RN, WOC(C); Vascular Nurse Specialist, The Ottawa Hospital Limb Preservation Centre, Ottawa, Canada
- **Leanne Atkin**, MHSc, RGN, PhD; Vascular Nurse Consultant, Mid Yorkshire Hospitals NHS Trust and University of Huddersfield, UK
- **Terry Swanson**, Nurse Practitioner, Wound Management, Warrnambool, Victoria, Australia
- **Masahiro Tachi**, MD, PhD; Professor, Department of Plastic and Reconstructive Surgery, Graduate School of Medicine, Tohoku University, Sendai, Japan
- **Yih Kai Tan**, MD, FRCSEd, CWSP; Director of Vascular Services, Consultant Vascular and Endovascular Surgeon, Changi General Hospital, Singapore
- **Molina Vega de Coniga**, MD; Consultant Angiologist, Vascular and Endovascular Surgeon, Galdakao-Usansolo Hospital, Bizkaia, Spain
- **Dot Weir**, RN, CWOCN, CWS; Saratoga Hospital Center for Wound Healing and Hyperbaric Medicine, Saratoga Springs, New York, US
- **Randall Wolcott**, MD, CWS; Southwest Regional Wound Care Center, Lubbock, Texas, US

Reviewer panel:

- **Jitka Černohorská**, PhD; Dermatologist, Dermal Centre, Mělník, Czech Republic
- **Guido Ciprandi**, MD, PhD; Chief Wound Care Surgical Unit, Division of Plastic and Maxillofacial Surgery, Bambino Gesù Children's Hospital, Research Institute, Rome, Italy
- **Joachim Dissemond**, MD; Professor of Dermatology and Venerology, University of Essen, Germany
- **Garth A. James**, PhD; Associate Research Professor of Chemical and Biological Engineering, Director, Medical Biofilm Laboratory, Center for Biofilm Engineering, Montana State University, Bozeman, Montana, US
- **Jonny Hurlow**, GNP-BC, WOCN; Wound Specialized Advanced Practice Nurse, Advanced Wound Care, Southaven, Mississippi and West Memphis, Arkansas, US
- **José Luis Lázaro Martínez**, DPM, PhD; Professor and Chief of Diabetic Foot Unit, Complutense University of Madrid, Spain
- **Beata Mrozikiewicz-Rakowska**, MD, PhD; Associate Professor, Diabetology and Metabolic Diseases Department, Medical University of Warsaw, Warsaw, Poland
- **Pauline Wilson**, BSc (Hons), SRChE, MCPod, MChS, PgDip, FFPM RCPS (Glas), Clinical Specialist Podiatrist, St James's Hospital, Dublin, Republic of Ireland

This document was supported by ConvaTec Limited.

Suggested citation for this document: Murphy C, Atkin L, Swanson T, Tachi M, Tan YK, Vega de Coniga M, Weir D, Wolcott R. International consensus document. Defying hard-to-heal wounds with an early antibiofilm intervention strategy: wound hygiene. J Wound Care 2020; 29(Suppl 3b):S1–28.

Editor: Tracy Cowan
Senior Project Manager and Chief Sub Editor: Camila Fronzo
Project Manager: Mercedes Arrieta
Medical Writer: Stephanie Wasik
Managing Director: Anthony Kerr: anthonykerr@markallengroup.com

Published by: MA Healthcare Ltd, St Jude's Church, Dunbar Road, London, SE24 0PB, UK
Tel: +44 (0)20 7738 6766 Web: www.markallengroup.com

Foreword

The enormous health and financial burdens incurred by delayed wound healing—often uninspiringly termed 'chronic wounds'—are acknowledged globally in research documents with alarming frequency. Affected individuals suffer increased pain and are vulnerable to recurrent infections, as they live with a health condition that is poorly understood by many healthcare providers. These wounds are commonly expected not to resolve. It might even be said this outcome is simply accepted.

In recent years, evidence has been growing that a key pathology of non-healing wounds is biofilm, just like plaque in dental disease. In biofilm disorders, pain and infection increase the need for analgesics, opioids and antibiotics, making it highly desirable to address the pathology before the disease escalates. Biofilm management is vital, therefore, to achieving better outcomes and reducing the disease burden. Much like dental hygiene, wound hygiene aims to root out the cause of a common pathology in the global population.

The concept of wound hygiene arose during an expert advisory board meeting held in early 2019. There, the international panel agreed that almost all hard-to-heal wounds contain biofilm, which delays or stalls healing. This led to the publication of an expert opinion article in *JWC* that posed the important question: is the current standard of care for wound management adequate, given what we now know about biofilm?[1]

There was a growing perception among the panel that wound care is in crisis. Perhaps it is. Globally, there is a perfect storm brewing in wound care: an ageing population; an increase in age- and lifestyle-associated conditions such as vascular disease, diabetes (which is pandemic) and obesity; economic strains in healthcare systems worldwide; overuse of antibiotics alongside increasing antibiotic resistance; and the ongoing severe impact of wounds on quality of life. Despite all the new products and best practices, the burden of wounds is not getting smaller. There is no magic recipe that rapidly improves non-healing wounds with consistent, reproducible results in all settings.

It is clear that the puzzle is missing a piece. Evidence is mounting that this piece is biofilm management, which is increasingly recognised as a factor in a multitude of chronic disease conditions. It may be time to rethink what constitutes best practice, particularly in wounds that are colonised by biofilm or infected.

At the expert advisory meeting, the panel discussed ways of embedding real change into generalist practice. Hence, it devised the concept of wound hygiene, which is based on the premise that, just as we follow basic hygiene everyday by washing our hands, brushing our teeth and showering to keep clean and ward off germs, so we should apply basic hygiene to wounds.

The panel met in summer 2019 to discuss the structure and content of this concept, with a view to publishing a consensus document in *JWC*. The result is this publication, which defines wound hygiene, describes how it can help reduce antibiotic usage and advises how it can be implemented into day-to-day practice. The international panel recognises this might need to take into account local standards and guidelines.

Christine Murphy
Panel chair

1. Murphy C, Atkin L, Swanson T, *et al.* Defying hard-to-heal wounds with an early antibiofilm intervention strategy: "wound hygiene". *J Wound Care* 2020;29:62–73. https://doi.org/10.12968/jowc.2020.29.2.62

The rationale for wound hygiene

Despite advances in dressing technology and best practice, wound care is in crisis: the number of hard-to-heal wounds is increasing and the implications for the healthcare system, including greater antibiotic usage, are challenging (Figure 1).[1-13] To improve the management of hard-to-heal wounds, it is necessary to address the tenacious biofilm that is present in most of them.[14]

Biofilm management involves regular debridement followed by antibiofilm re-formation strategies, including the use of topical antimicrobial dressings.[14] This consensus document suggests there is a need to go further by implementing a new strategy, called wound hygiene, which involves two additional stages: cleansing the wound and periwound skin, and refashioning the wound edge. Wound hygiene is a structured method for overcoming the barriers to healing associated with biofilm. This document therefore dispenses with the term chronic wounds in favour of hard-to-heal wounds, signifying that these barriers can be overcome.

Biofilm: the primary barrier to healing?

When a wound is hard-to-heal, the interruption in the healing process is largely associated with the presence of tenacious biofilm (a community of multispecies microbes). Although other underlying host factors may also present obstacles to healing, it is increasingly acknowledged that a majority—if not all—non-healing wounds contain biofilm, which is a key barrier to healing.[15,16] Figure 2 illustrates how biofilm develops.

An increase in the number and complexity of microbes in any tissue environment will increase the risk of infection. This risk multiplies where there is increased microbial virulence, antibiotic/antimicrobial resistance and tolerance, and/or the host defences are impaired—for example, due to diabetes and obesity.[17]

Lessons from oral hygiene

In oral health, the presence of biofilm (dental plaque) on the teeth and between the enamel and gums (gingival crevices) is the most widely accepted cause of periodontal diseases.[18]

Oral biofilm re-forms quickly—within 24 hours of oral hygiene.[18] This is why it is recommended to floss and brush twice daily, each time approximately halfway through this cycle of biofilm re-formation.[19] It is estimated that 50–90% of adults worldwide are affected by gingivitis, which is a mild, reversible form of periodontal disease that can be managed with improved oral hygiene.[18] The importance of repetitive, regular and frequent oral hygiene cannot be overstated.

There are lessons from this for wound care. Wound biofilm is an independent factor that delays or stalls healing. In the past, before the effects of wound biofilm were understood, wounds were regarded as being akin to a garden that needs gentle tending. However, it could be more appropriate to perceive the wound bed as a battlefield, where biofilm is the enemy whose presence can result in stalled or non-healing, amputation, impaired quality of life and a large associated socioeconomic burden.[20,21] The health professional therefore engages in battle when managing the hard-to-heal wound, where the goal is to disrupt and remove the wound biofilm and prevent its re-formation. Wound hygiene provides health professionals with a toolkit to do this.

Translation to wound hygiene

The presence of biofilm in hard-to-heal wounds and its significant contribution to delayed healing is well documented.[14,22–24] To initiate and support healing, the biofilm must therefore be disrupted/removed.[25]

There is still debate about the signs and symptoms associated with wound biofilm, but there is a growing consensus that these include both the covert and overt signs of local wound infection.[26] Furthermore, although some say that when a biofilm is mature, a slimy film may

A large and growing population

Population affected:

2–6% of the population worldwide[1]

2.2 million people with wounds in the UK[2,3]

+50 million more people aged ≥65 years by 2050[4]

Wounds: billion-dollar issue worldwide

$28 billion/year in the US (primary wound diagnosis)[5]

$31.7 billion/year (secondary diagnosis)[5]

2–4% of healthcare expenditures across Europe and rising[6–8]

High impact on antibiotic use

16.4% of antibiotic prescriptions attributed to wound care[9]

Impact on healthcare systems

UK: 25–50% of acute hospital beds occupied by patients with wounds[8]

Republic of Ireland: up to 66% of community nurses devoted to wound care[10,11]

Sweden: 57 full-time nurses needed per year just for dressing changes[12]

The human cost

In the US, venous leg ulcers: 2 million working days lost per year[4]

Biggest impact for patients: pain and impaired mobility[13]

Quality of life for patients with wounds: similar to that of patients with chronic obstructive pulmonary disease (COPD) and cardiovascular diseases[13]

Figure 1. *Wound care in crisis*

Key term

Hard-to-heal wound

A wound that has failed to respond to evidence-based standard of care. The concept of wound hygiene is based on the premise that all hard-to-heal wounds contain biofilm. Because of the speed with which wound biofilm forms, a wound that exhibits exudate, slough and an increase in size by the third day of its occurrence may already be defined as hard-to-heal.

form on the wound surface, this is contested,[4] and all agree it is not possible to make a definitive diagnosis by eye alone.[5] Advanced molecular biology and microscopy techniques are required to confirm its presence, but these are expensive and not widely available to most health professionals. The panel therefore proposes that it should always be assumed that hard-to-heal wounds contain biofilm, which is located primarily on the wound surface (although aggregates may appear in deeper tissue) and is inconsistently distributed across and within the wound.[3,4,6,7]

Based on the evidence and current state of practice, a well-planned and systematic approach to wound cleansing is needed to prepare hard-to-heal wounds for management.[4] The wound hygiene concept was developed to meet this need. It proposes that, to promote healing, the biofilm must be managed early with a strategy comprising:

- Cleansing (of both the wound and periwound skin)
- Debridement (initial aggressive debridement if necessary, as well as maintenance)
- Refashioning the wound edges
- Dressing the wound.

At times, these approaches will need to overlap. Implementation of the wound hygiene concept can help convert the wound biofilm battleground into a more peaceful landscape, in which the wound can progress towards healing.

✖ **MYTH** | Addressing the wound pathophysiology and patient comorbidities will address the cause of the wound.

✔ **REALITY** | Wound hygiene should be implemented at the same time that the underlying causes of the wound and the patient's morbidities are being addressed. This will ensure that the wound pathology and wound biofilm are managed simultaneously.

Wound hygiene: steps in the strategy

Hygiene is, of course, a fundamental and long-accepted concept. Implementation of hygiene strategies, such as hand hygiene and surgical asepsis, have radically improved population health.

Wound hygiene is a powerful toolkit. Its use in combination with the TIMERS (tissue, inflammation, moisture, edge, regeneration/repair, social factors) framework[3] will help establish biofilm management as the optimal wound-care strategy. It can be used on all wounds, including acute and postoperative.

The core principle of wound hygiene is to remove or minimise all unwanted materials, including biofilm, devitalised tissue and foreign debris, from the wound, address any residual biofilm, and prevent its re-formation. This will kickstart healing.

Like all forms of hygiene, the hallmark of wound hygiene is repetition: the wound must be cleansed, debrided and

Key term

Wound biofilm

A complex community of different species of bacteria and fungi that causes a sustained subclinical wound infection, but can protect itself from the host's immune response and is tolerant to antibiotics and antiseptics.[4] Biofilm can form within hours and can reach maturity in 48–72 hours[4] (Figure 2).

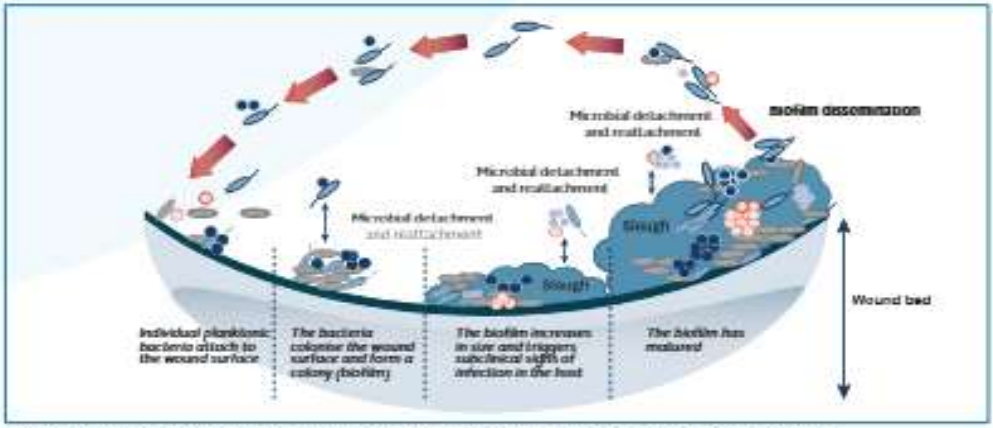


Figure 2. *Illustration depicting the stages of biofilm formation and maturity. Adapted from Percival[19]*

The wound hygiene concept proposes that wound biofilm can be managed, provided that all underlying aetiologies, such as chronic venous insufficiency or peripheral arterial disease, are addressed and the patient receives gold standard care. A full holistic assessment is essential to achieve this

Figure 3. *Wound before (a) and 10 minutes after (b) wound hygiene. Note the superficial slough and condition of the peri-wound skin pre-wound hygiene*

Figure 4. *Wound before (a) and 10 minutes after (b) wound hygiene. The same wound after the next episode of wound hygiene, one week later (c)*

its edges refashioned at every assessment and dressing change. Like hygiene in general, it is not an optional activity.

Figure 5. *Wound before (a) and after wound hygiene later that day (b). The same wound after 1 week (c), 2 weeks (d) and 4 weeks of weekly wound hygiene (e). The wound healed in 5 weeks (f)*

The goal of this document is to establish the concept of wound hygiene as a core and non-negotiable component of wound care. Figures 3–5 show how implementation of wound hygiene promotes healing. Table 1 describes and Figure 6 illustrates the four activities of wound hygiene.

01

Cleanse the wound and periwound skin

Cleanse the wound bed to remove devitalised tissue, debris and biofilm. Cleanse the periwound skin to remove dead skin scales and callus, and to decontaminate it

02

Debride

Remove necrotic tissue, slough, debris and biofilm at every dressing change

03

Refashion the wound edges

Remove necrotic, crusty and/or overhanging wound edges that may be harbouring biofilm. Ensure the skin edges align with the wound bed to facilitate epithelial advancement and wound contraction

04

Dress the wound

Address residual biofilm while preventing or delaying regrowth of biofilm by using dressings containing antibiofilm and/or antimicrobial agents

Figure 6. *The four activities of wound hygiene*

References

1. Jarbrink K, Ni G, Sonnergren H et al. The humanistic and economic burden of chronic wounds: a protocol for a systematic review. Systematic Reviews [illegible]
2. Campbell D. Chronic wounds: the hidden health crisis hitting [illegible] Britons. The Guardian [illegible] https://[illegible] (accessed [illegible] February [illegible])
3. Guest JF, Ayoub N, McIlwraith T et al. Health economic burden that wounds impose on the National Health Service in the UK. BMJ Open [illegible]
4. Sen CK, Gordillo GM, Roy S et al. Human skin wounds: a major and snowballing threat to public health and the economy. Wound Repair Regen [illegible]
5. Nussbaum SR, Carter MJ, Fife CE et al. An economic evaluation of the impact, cost, and medicare policy implications of chronic nonhealing wounds. Value in Health [illegible] https://doi.org/[illegible]
6. Purwins S, Herberger K, Debus ES et al. Cost-of-illness of chronic leg ulcers in Germany. Int Wound J [illegible]
7. Hjort A, Gottrup F. Cost of wound treatment to increase significantly in Denmark over the next decade. J Wound Care [illegible] https://doi.org/[illegible]
8. Posnett J, Gottrup F, Lundgren H et al. The resource impact of wounds on health-care providers in Europe. J Wound Care [illegible] https://doi.org/[illegible]
9. Dolk FC, Pouwels KB, Smith DR et al. Antibiotics in primary care in England: which antibiotics are prescribed and for which conditions? J Antimicrob Chemother [illegible] https://doi.org/[illegible]
10. Clarke-Moloney M, Keane N, Kavanagh E. An exploration of current leg ulcer management practices in an Irish community setting. J Wound Care [illegible] https://doi.org/[illegible]
11. Clarke-Moloney M, Keane N, Kavanagh E. Changes in leg ulcer management practice following training in an Irish community setting. J Wound Care [illegible] https://doi.org/[illegible]
12. Lindholm C, Bergsten A, Berglund E. Chronic wounds and nursing care. J Wound Care [illegible] https://doi.org/[illegible]
13. Olsson M, Järbrink K, Divakar U et al. The humanistic and economic burden of chronic wounds: A systematic review. Wound Repair Regen [illegible]
14. Bjarnsholt T, Eberlein T, Malone M et al. Management of biofilm. Wounds International [illegible]
15. Schultz G, Bjarnsholt T, James GA et al. Consensus guidelines for the identification and treatment of biofilms in chronic nonhealing wounds. Wound Repair Regen [illegible] https://doi.org/[illegible]
16. Malone M, Swanson T. Biofilm-based wound care: the importance of debridement in biofilm treatment strategies. Br J Community Nurs [illegible]
17. Centers for Disease Control (CDC). The biggest antibiotic-resistant threats in the US. Centers for Disease Control and Prevention [illegible] https://www.cdc.gov/drugresistance/biggest-threats.html (accessed [illegible] February [illegible])
18. Mancl KA, Kirsner RS, Ajdic D. Wound biofilms: lessons learned from oral biofilms. Wound Repair Regen [illegible] https://doi.org/[illegible]
19. Stewart PS. Biophysics of biofilm infection. Pathog Dis [illegible]
20. Wolcott RD, Rhoads DD, Bennett ME et al. Chronic wounds and the medical biofilm paradigm. J Wound Care [illegible]
21. Nussbaum SR, Carter MJ, Fife CE et al. An economic evaluation of the impact, cost, and medicare policy implications of chronic nonhealing wounds. Value Health [illegible] https://doi.org/[illegible]
22. Atkin L, Bućko Z, Montero EC et al. Implementing TIMERS: the race against hard-to-heal wounds. J Wound Care [illegible]
23. Haesler E, Swanson T, Ousey K et al. Clinical indicators of wound infection and biofilm: reaching international consensus. J Wound Care [illegible] https://doi.org/[illegible]
24. International Wound Infection Institute (IWII). Wound infection in clinical practice: international consensus update [illegible]. Wounds International [illegible]
25. Metcalf DG, Bowler PG. Biofilm delays wound healing: A review of the evidence. Burns Trauma [illegible] https://doi.org/[illegible]
26. White RJ, Cutting KF. Wound biofilms: are they visible? J Wound Care [illegible]
27. Fletcher J, [illegible], Rippon J, Fiddy JA. Clinical investigation of biofilm in non-healing wounds by high resolution microscopy techniques. J Wound Care [illegible] https://doi.org/[illegible]
28. Percival SL, Mayer D, Kirsner RS et al. Surfactants: Role in biofilm management and cellular behaviour. International Wound Journal [illegible]
29. Atkin L, Bućko Z, Montero EC et al. Implementing TIMERS: the race against hard-to-heal wounds. J Wound Care [illegible]
30. Wolcott RD, Rumbaugh KP, James G et al. Biofilm maturity studies indicate sharp debridement opens a time-dependent therapeutic window. J Wound Care [illegible] https://doi.org/[illegible]
31. Percival SL. Importance of biofilm formation in surgical infection. Br J Surg [illegible] https://doi.org/[illegible]

CALL TO ACTION

Service providers should ensure that policies are in place so that every health professional (generalist and specialist) can undertake some degree of wound hygiene. The panel believes that implementing wound hygiene can result in better healing rates and times, fewer antibiotic prescriptions, improved quality of life and wellbeing for patients, and significant cost savings for buyers and purchasers.

Wound hygiene: stage 1—cleanse

Cleansing helps to achieve the goals of wound hygiene by removing loose material, excess exudate and debris, and disrupting biofilm.[1,2] It sets the stage for biofilm disruption, the removal of residual biofilm and prevention of biofilm re-formation. As the wound bed and periwound skin are likely to contain biofilm, both areas must be cleansed. This should be done with as much physical force as the patient can tolerate. The procedure should be repeated at each dressing change and after debridement. The selection of cleansing agents and choice of cleansing techniques will be based on clinical assessment.

Cleansing for wound hygiene

Key term

Actively removing surface contaminants, loose debris, slough, softened necrosis, microbes and/or remnants of previous dressings from the wound surface and its surrounding skin.[10]

Cleansing the skin and wound

Cleansing the periwound skin and wound bed to remove unwanted material—both visible and invisible to the naked eye—is a cornerstone of wound care, as it promotes a balanced environment in which healing can take place.[3] As well as biofilm, the periwound skin can contain debris comprising lipids, fragments of keratinised cells, sebum and sweat, in which small amounts of electrolytes, lactate, urea and ammonia are found. These create an ideal environment for microbial proliferation and biofilm formation. Figure 7 shows an example of cleansing the skin.

Importance of using an appropriate cleanser

Standard use of saline or water rinses will not remove biofilm.[4] Instead, surfactants are widely used to help remove foreign matter, biological debris[5] and biofilm.[6] The surfactant lowers the surface or interfacial tension between a liquid and a solid (such as debris and biofilm), helping to disperse the latter, which can then be removed more easily with a cleansing pad or cloth.[5]

According to Malone and Swanson, loose, non-viable or devitalised tissue can be removed if covered with a surfactant-based wound solution or gel for sufficient time (usually 10–15 minutes) and lightly cleansed with sterile gauze. However, the evidence on the ability of surfactants to remove wound biofilm is low and mainly *in vitro*.[6]

The panel encourages the use of surfactant-containing antiseptics or pH-balanced solutions to cleanse both the wound bed and periwound skin as part of wound hygiene, where possible in accordance with local practice.[7] Highly cytotoxic solutions, such as those containing povidone-iodine and hydrogen peroxide, are not recommended.[7,8] Ideally, a skin cleanser designed for daily use should be chosen, to balance the need to disrupt the microbial load while maintaining skin integrity.[9]

Table 2 outlines solutions that can be used to cleanse the wound and periwound skin, although selection might depend on local guidelines.

✖ MYTH | Never put anything into a wound that you wouldn't put into your eye.

✔ REALITY | The wound bed is not a virgin tissue, it is a battleground that requires active intervention with cleansing, debridement, refashioning of the wound edges and strategies to prevent biofilm re-formation. This will create the conditions in which the battleground can become a 'garden' and healing can occur. Agents that may be toxic or too strong should be avoided once a positive healing trajectory has been established.

Table 2. Solutions for cleansing in wound hygiene*

Solution	Rationale
Non-antiseptic	
Water	• Ineffective in reducing bacterial load • Taps can be colonised with viable microbes: the presence of *Pseudomonas aeruginosa* in plumbing systems is well documented • Ineffective in reducing bacterial load • Single-use sterile containers are no longer sterile after opening
Saline	• Ineffective in reducing bacterial load • Low toxicity • Single-use, as bacterial growth can occur within 24 hours of opening
Surfactant-containing solution	• Due to their surfactant content, some formulations have been shown to disrupt microbial load when less force is applied • Some formulations have shown antibiofilm capabilities *in vitro* by reducing microbial attachment and biofilm formation • Gentle to healthy cells and can restore cellular integrity
Antiseptics	
Polyhexamethylene biguanide	• Some formulations also contain an antimicrobial substance and a surfactant • Broad spectrum of activity against microbes with no evidence of resistance
Octenidine dihydrochloride	• Some formulations contain a preservative and a surfactant-like molecule that loosens dressings and aids cleansing • Shown to prevent and remove the growth of bacterial biofilms
Hypochlorous acid	• Rapid, broad-spectrum antimicrobial activity with low cytotoxicity • Can be used to loosen dressings as well as for cleansing
Chlorhexidine gluconate	• Widely used in diluted concentrations for skin and oral applications • Laboratory tests have shown it is effective against a variety of bacteria and fungi, including *Staphylococcus* and meticillin-resistant *Staphylococcus aureus*, *Pseudomonas aeruginosa* and *Candida albicans* • Antimicrobial activity is more effective with longer dwell times • Allergic-reaction rate in surgical patients is approximately 0.78 per 100,000 exposures, but it can also cause irritant contact dermatitis or allergic contact dermatitis

*Follow local protocols for using solutions in practice

*Study did not include examination for and cannot be interpreted for biofilm infection (non-acute infection)

19. Hosen H, Rani SA, Wang L et al. Antimicrobial activity comparison of pure hypochlorous acid (0.01%) with other wound and skin cleansers at non-toxic concentrations. SAWC Spring and WHS 2013
20. Koburger T, Hübner N-O, Braun M et al. Standardized comparison of antiseptic efficacy of triclosan, PVP-iodine, octenidine dihydrochloride, polyhexanide and chlorhexidine digluconate. J Antimicrob Chemother 2010;65(8):1712–9. https://doi.org/10.1093/jac/dkq212
21. Cook T. Chlorhexidine. Report and findings of the 6th National Audit Project. Royal College of Anaesthetists. London: Royal College of Anaesthetists, November 2015; pp 192–202. https://tinyurl.com/[illegible] (accessed 14 February 2020)

Wound hygiene: stage 2—debride

The goal of debridement is to remove/minimise all unwanted materials (Box 1), even if some healthy tissue is also removed. Debridement is required as part of the biofilm 'weeding' process, to convert the hostile wound battleground into a blossoming 'tissue garden' (Table 3). A variety of debridement methods can be used, potentially starting with more intensive methods, if necessary, and then progressing to mechanical debridement. This process is a vital part of wound hygiene and should be administered to all hard-to-heal wounds.

Autolytic debridement—use of the body's own naturally occurring enzymes to break down devitalised tissue—is insufficient to meet the debridement requirements of wound hygiene, as it takes a long time to occur, requires numerous dressing changes and can increase the risk of infection in hard-to-heal wounds.[1,2] Furthermore, it relies on the efficiency and effectiveness of the host processes, which are likely to be compromised in hard-to-heal wounds.[3]

A faster and more effective method is needed to disrupt biofilm, address any residual biofilm and prevent re-formation in hard-to-heal wounds: debridement (Table 3).

Importance of proactive debridement in wound hygiene

Proactive debridement is an integral part of wound hygiene, as it will help any wound not covered with granulation tissue to progress towards healing.[4] Selection of the method of debridement should be based on assessment of the wound bed, the periwound skin, and the patient's pain and tolerance levels. Mechanical force, in combination with a surfactant or antimicrobial solution, are effective ways of breaking up and clearing biofilm.[5]

Combined use of a topical surfactant-based wound cleansing solution and a debridement pad or gauze will augment cleansing sufficiently to disrupt and remove biofilm. When physical debridement is contraindicated, it might be possible to use this approach instead.[6] The result is a well-tended 'garden' in which the undesirable matter has been 'weeded' out, to provide a healthy environment for growth—in this case, of new tissue.[7] Debridement decontaminates the wound bed and removes biofilm, thereby preparing it for dressing application, in line with the principles of wound bed preparation.[8]

Box 1. Targets of removal with debridement in wound hygiene[8,14]

Biofilm
Devitalised tissue (necrosis, slough, eschar)
Excess exudate
Impaired tissue (inflamed or infected)
Serocrusts
Hyperkeratosis
Pus
Haematomas
Foreign bodies
Debris
Remains of previous dressings
Any other types of bioburden/barriers to healing

✖ MYTH | Wet-to-dry dressings provide adequate debridement for healing to occur.

✔ REALITY | The wet-to-dry method can cause substantial pain and distress, resulting in poor patient concordance or adherence to management. With wound hygiene, the wound bed can be debrided without traumatising patients and the biofilm disrupted, removed and its re-formation prevented.

To avoid the risk of injury, the panel acknowledged the need to use caution when considering debriding lower extremity wounds in patients with poorly perfused limbs and autoimmune conditions such as pyoderma gangrenosum.

Similarly, mechanical debridement should be undertaken with caution in patients with bleeding disorders or who are on anticoagulation therapy, and/or who are in intolerable or unpreventable pain. A full clinical assessment by a

Table 3. Debridement options

Approach	Description	Key points
Surgical	Procedure performed in the surgical suite/operating theatre, frequently under general, regional or local anaesthesia, using various surgical instruments to cut away tissue.[8]	The patient's condition, the skill level required of the health professional and lack of reimbursement can limit referral for and implementation of surgical debridement. Removes tissue and disrupts biofilm at both the surface and in deeper tissues.[8]
Sharp (curette, scalpel, scissors and forceps)	An often less-aggressive procedure that can be performed at the bed- or chairside. Using an aseptic technique, debris and devitalised tissue are physically removed with sharp instruments.[8]	Removes superficial tissue and disrupts biofilm.[8] Effective in stimulating healing of hard-to-heal wounds.[9] Safe, well tolerated and can be performed in an outpatient setting.[10] Skills required of the health professional can limit implementation.
Larval[a] (also known as biosurgery)	Specific species of live maggots, raised and disinfected for patient use, are placed on devitalised tissue, where they secrete enzymes that liquify the tissue prior to ingestion; the maggots also secrete antimicrobial substances.[8]	Disrupts the tissue-collagen matrix and exerts a bacteriostatic effect.[8] Promotes wound healing and amplifies human fibroblast and chondrocyte growth.[8] Good *in vitro* evidence of biofilm removal.[8]

Continued opposite

Figure 8. Sharp (blade) debridement to remove all devitalised tissue (superficial and deep), wound debris and biofilm, to leave the wound bed in a state conducive to the effective use of antimicrobial dressings (a–e). Note the pinpoint bleeding (b and c). Fig c shows refashioning of the wound edges to remove biofilm. Fig d includes a detail of the debrided material and pinpoint bleeding. Fig e shows the wound after wound hygiene; notice the difference in the periwound skin, wound bed and wound edges. The ulcer requires the same process of wound hygiene (all four steps) at each dressing change

✖ MYTH | Do not remove loose scales, scabs or slough, as healing is occurring underneath them.

✔ REALITY | Slough inhibits healing. Scales and scabs harbour microbes and so must be removed to promote healing.

Table 3. Debridement options (continued)

Approach	Description	Key points
Ultrasonic†	Direct application to the wound bed of sound-wave energy, delivered from a device, which disrupts biofilm, induces light bleeding to stimulate growth factors, and improves granulation and local perfusion.	Can destroy, dislocate or physically modify tissue and biofilm.[8] Statistically significant reduction in bacterial load compared with surgical debridement after 6 weeks' follow-up.[20] Exhibits some levels of disruption and biofilm removal, leaving behind a small amount of contaminants.[8,20]
Mechanical debridement†	Soft debridement pad, gauze or wipes to physically remove devitalised tissue, debris and organic matter.	Can be undertaken by all clinicians with minimal training. Exhibits some levels of disruption and biofilm removal.[8] Efficiently removes debris, slough, dried exudate and crusts without damaging the periwound skin.[21]

* Types of biological debridement
† Types of mechanical debridement

Before using an antiseptic solution, if indicated, the wound might need to be swabbed and cultured. Box 2 describes how to do this.

References

1. Gray D, Acton C, Chadwick P *et al.* Consensus guidance for the use of debridement techniques in the UK. Wounds UK 2010;6(4).
2. Allen L. Understanding methods of wound debridement. Br J Nurs 2014;23(Sup10):S14–15. https://doi.org/10.12968/bjon.2014.23.sup10.S14
3. MacLeod AS, Mansbridge JN. The Innate Immune System in Acute and Chronic Wounds. Adv Wound Care (New Rochelle) 2016;5(2):65–78. https://doi.org/10.1089/wound.2014.0608
4. Sharp A. Ultrasonic debridement in a changing NHS. A UK consensus. Wounds UK 2015;9(Suppl 1).
5. Stewart PS. Biophysics of biofilm infection. Pathog Dis 2014;70:212–18. https://doi.org/10.1111/2049-632X.12118
6. Malone M, Swanson T. Biofilm-based wound care: the importance of debridement in biofilm treatment strategies. Br J Community Nurs 2017;22(Sup6):S20–5. https://doi.org/10.12968/bjcn.2017.22.Sup6.S20
7. Schultz GS, Woo K, Wise D *et al.* Effectiveness of a monofilament wound debridement pad at removing biofilm and slough: in vivo and clinical performance. J Wound Care 2018;27(6):390–401. https://doi.org/10.12968/jowc.2018.27.6.390
8. Strohal R, Dissemond J, Jordan O'Brien J *et al.* EWMA document: Debridement. An updated overview and clarification of the principle role of debridement. J Wound Care 2013;22(1). https://doi.org/10.12968/jowc.2013.22.Sup1.S1
9. Tipdirakij DC, Salisbury A, Chen D *et al.* Surfactants and their role in biofilm management in chronic wounds. Wounds International 2015;6(1):20–24.
10. Castillo-Hill I, Smith IW. Wound cleansing: the evidence for the techniques and solutions used. Prof Nurse 2000;16:85–9.
11. Bishop SM, Walker M, Rogers AA *et al.* Importance of moisture balance at the wound-dressing interface. J Wound Care 2003;12:125–8. https://doi.org/10.12968/jowc.2003.12.4.26484
12. Wilcox JR, Carter MJ, Covington S. Frequency of debridements and time to heal: a retrospective cohort study of 312 344 wounds. JPMA Dermatol 2013;143:1050–8. https://doi.org/10.1001/jamadermatol.2013.4960
13. Roy H, Tacon M, Trowell C *et al.* Strategies for combating bacterial biofilms: A focus on anti-biofilm agents and their mechanisms of action. Virulence 2018;9:522–54. https://doi.org/10.1080/21505594.2017.1313372
14. Schultz G, Bjarnsholt T, James GA *et al.* Consensus guidelines for the identification and treatment of biofilms in chronic nonhealing wounds. Wound Repair Regen 2017;25:744–57. https://doi.org/10.1111/wrr.12590
15. Chen J, Nixon J, Nelson EA *et al.* Autolytic debridement for pressure ulcers. Cochrane Database of Systematic Reviews 2014. https://doi.org/10.1002/14651858.CD001231
16. Kalmbach G. Are quantitative bacterial wound cultures useful? J Clin Microbiol 2004;42:2753–6. https://doi.org/10.1128/JCM.42.6.2753-2756.2004
17. Snyder RJ, Bohn G, Han J *et al.* Wound Biofilm: Current perspectives and strategies on biofilm disruption and treatments. Wounds 2017;29:1–17
18. International Wound Infection Institute (IWII). Wound infection in clinical practice: international consensus update 2016. Wounds International 2016.
19. Williams D, Enoch S, Miller D *et al.* Effect of sharp debridement using curette on escalation of secondary wound dressings in concurrently controlled, prospective cohort study. Wound Repair Regen 2015;23:338–47. https://doi.org/10.1111/wrr.12296
20. Van Acker K, Bruaenaere C, Cichter D *et al.* Report of 2-cleared panel meeting on ultrasound-assisted wound debridement. J Wound Care 2020; In press.
21. Cranick MS, Faulkhurst C, Shanmugam M *et al.* Direct-contact low-frequency ultrasound clearance of biofilm from metallic implant materials. J Orthop 2013;3

Figure 22. *Venous leg ulcer before (a) and after (b) wound hygiene. There is debris on the wound bed, scales and some exudate on the periwound skin pre-wound hygiene (a). During wound hygiene, the periwound area was cleansed, and skin scales and exudate were removed. Similarly, all exudate and debris were removed from the wound bed, leaving good, vital granulating tissue. The wound edges were also debrided and refashioned, aiding epithelialisation*

Figure 23. *Examples of cliffs (a), (b) and beaches (c). Fig 23b shows surgical dehiscence, with exudate and debris on the wound bed, mild periwound inflammation and cliffs at the wound edges, where there is an abrupt and vertical transition between skin and wound bed that is not conducive to epithelialisation*

Figure 24. *Small ischaemic ulcer after revascularisation: it has both cliffs and beaches. In the upper half of the wound, the granulating wound bed and edges represent beaches, where there are signs of epithelialisation and a smooth transition to the periwound skin. In the bottom half, there is a blunt and vertical transition between the wound and periwound skin (cliffs) that is more resistant to epithelialisation. (The periwound skin debris still needs to be removed)*

It is also necessary to remove hyperkeratosis or callus around hard-to-heal wounds. This principle is seen in diabetic foot ulcers, where standard practice has long been to remove callus and crust as part of wound bed preparation>

Implementing wound hygiene

All wounds, particularly hard-to-heal ones, will benefit from wound hygiene (Figure 14), which should be instigated at the first referral, following a full holistic assessment to identify the wound aetiology and comorbidities, and then implemented at every dressing change until full healing occurs. All aspects of the wound hygiene approach are listed in Box 3.

Wound hygiene can be safely implemented in any setting

Wound hygiene can be safely practised by specialist and generalist health professionals (Table 5 and Box 4). It should be applied in all settings, from postoperative to outpatients, GP practices and post-acute community practices (Table 6). As there are multiple methods of debridement to choose from, wound hygiene can be implemented by generalists and non-skilled health workers, provided the method chosen meets the wound's and patient's needs. Implementation involves consecutive application of all four stages and their various components. And yet members of the panel have found that, within their practice, wound

Figure 14. Evolution of an ulcer managed with wound hygiene at every dressing change: after one week (b), there is a significant reduction in the amount of wound debris (and thus biofilm present), with a satisfactory increase in the amount of granulation tissue present on the wound bed, and signs of healing at the wound edges

Box 3. Wound hygiene checklist

- ✓ Holistic assessment of the patient, wound and environment.
- ✓ Implement pain management as needed, in consultation with a specialist and/or anaesthetist, before and during the process.
- ✓ Cleanse the periwound skin.
- ✓ Cleanse the wound bed.
- ✓ Gain patient consent for debridement, in accordance with local policy.
- ✓ Ensure the underlying wound pathology does not contradict mechanical debridement.
- ✓ Conduct wound debridement in accordance with local policy.
- ✓ Cleanse both pre- and post-debridement.
- ✓ Refashion the wound edges.
- ✓ Select an appropriate dressing.
- ✓ Apply an appropriate dressing.
- ✓ **When in doubt, refer!**

hygiene can easily be carried out within a 10-minute patient consultation. Figure 15 depicts implementation of wound hygiene, as demonstrated by Dr Wolcott.

Anticipated benefits

The benefits of wound hygiene are expected to include lower rates of infection and chronic inflammation, as well as faster and higher healing rates. This could reduce

Table 5. Implementation of wound hygiene by clinical competency*

Skill level	Wound hygiene tasks
Unregistered/little or no wound training or certification	• Cleansing the wound bed and periwound skin. • Debridement of the wound bed and periwound skin with a soft pad or gauze. • Refashion the wound edges with a soft pad or gauze. • Assessing for signs of infection. • Application of a wound dressing.
Registered/some training in wound care	• Holistic assessment of the patient, wound (including vascular supply and infection status) and environment. • Sharp debridement of non-viable tissue (and ability to determine when it is appropriate). • Ultrasonic debridement. • Larval therapy. • Refashion the edges to achieve pinpoint bleeding. • Identification of local and spreading infection. • Selection and application of an appropriate dressing.
Expert/advanced (certified wound specialist, surgeon or other specialist consultant)	• Diagnosis and management of the underlying pathophysiology. • Pharmacotherapy, as required. • Selecting and undertaking an appropriate method of debridement (e.g. surgical sharp debridement). • Refashioning the wound edges. • Suturing, if required. • Selection and application of an appropriate dressing.

*Providers should follow their competencies and capabilities as determined by their local protocols, regulatory body, legal liability and local governing bodies.

Table 6. Implementation of wound hygiene by clinical settings

Setting	Wound hygiene tasks
Care or nursing home	• Showering to reduce the overall body microbial load. • Cleansing the wound bed and periwound skin using a surfactant or pH-balanced solution and dedicated sterile gauze. • Using a dedicated foot sink, washing under the shower head. • Debridement with a soft pad or gauze. • Refashioning the wound edges with soft pad or gauze. • Application of an appropriate dressing.
Community/patient's home	• Holistic assessment. • Cleansing the wound bed and periwound skin using a surfactant or pH-balanced solution. • Debriding the wound bed and periwound skin (e.g. with a curette). • Refashioning the wound edges. • Application of an appropriate dressing.
Outpatient/inpatient specialist	• Holistic assessment. • Diagnosing and managing the underlying pathophysiology. • Cleansing the wound bed and periwound skin with a surfactant or pH-balanced cleanser. • Debridement of the wound and periwound skin. • Other types of mechanical debridement or sharp (surgical, curette, ultrasonic) debridement. • Achieving pinpoint bleeding. • Refashioning the wound edge. • Selection and application of an appropriate dressing.

A moisturiser, barrier cream or topical steroid may be applied to maintain skin health

Figure 5: *Implementation of wound hygiene, as demonstrated by Randy Wolcott.*

At presentation, the wound is covered with eschar glued and desiccated skin tissue, which contains biofilm (a).

A foam sponge impregnated with an approved surfactant is an excellent choice for removing scale and eschar due to its ability to apply, hold and agitate fluids over the wound (b). The sponge is soaked in a large amount of warm water and wiped over the wound for several minutes to solubilise any adherent tissue. Next, a second foam sponge is soaked in the water and then used to cleanse the periwound skin aggressively to beyond the area that will be covered by a wound dressing, as this will be seeded with numerous pockets of detached biofilm. Finally, a third sponge is used to aggressively remove any remaining material, which by now is hydrated after having been soaked (c).

If the condition of the wound bed and periwound skin is such that a more aggressive tool is required, or if dry material, especially eschar, is present, a surgical scrub brush can be considered (d and e). However, a surgical brush may require local anaesthesia and it will also remove viable host tissue, but this will quickly repair itself. Remember: the goal is to remove biofilm as completely and frequently as possible. Using a surgical scrub brush along with an antiseptic may dry the periwound skin, making it helpful to moisturise it. Antiseptics are only minimally effective against biofilm fragments that seed the skin, so it is better to scrub with surfactants to remove and disrupt the biofilm.

Gauze is an effective substitute to a sponge (f). Additional fluid needs to be added to the gauze almost constantly, and it will soon need to be replaced with a fresh piece of gauze depending on the amount of devitalised tissue it collects. The wound can be scrubbed with gauze until there is pinpoint bleeding or no adherent devitalised tissue is present (g). If the patient finds this too painful, the current session of wound hygiene should be stopped, to be resumed another time. Topical anaesthetics can be considered in such cases.

In this case, most of the eschar was easily removed with soaking and gentle scrubbing (h). A stiffer surgical scrub removed most of the rest, causing minimal pain.

Consensus statements summary

General

1. Wound hygiene is a fundamental aspect of care for all patients with an open wound.
2. It should be assumed that all hard-to-heal wounds contain biofilm.
3. Non-healing should be regarded as a pathology that can be successfully addressed with the right tools, provided that the underlying aetiology is managed with gold standard care.
4. Wounds should be triaged by level of risk, regardless of their duration.
5. Wound hygiene should be performed at every dressing change.
6. The skills, materials and time required to carry out wound hygiene make it a cost-effective approach, especially given its potential to promote faster healing.
7. Assess and manage the patient's pain expectations.
8. Even if the wound does not 'look' like it has biofilm, wound cleansing must be a priority.

Cleanse

9. When cleansing the periwound skin, concentrate on the area that is 10–20 cm away from the wound edges, or that is covered by the dressing, whichever is larger.
10. Use an antiseptic wash or surfactant for cleansing, if possible, and avoid cross-contamination.

Debride

11. Debridement is an integral part of wound hygiene; the choice of method should be based on assessment of the wound bed, periwound skin and patient tolerance.
12. Any instrument used for debridement must be sterile.
13. To avoid risk of injury, exercise caution when considering debriding lower extremity wounds in patients with poorly perfused limbs and autoimmune conditions, such as pyoderma gangrenosum.

Refashion the wound edge

14. Wound bed fragility is rarely an issue: removing all devitalised and even some healthy tissue from the wound edges will result in regrowth of healthy tissue.
15. Any undermining, no matter how slight, needs to be addressed either by loosely packing with a dressing material or refashioning the wound edges.

Dress the wound

16. By disrupting and clearing biofilm, and preventing its re-formation, wound hygiene is expected to reduce the risk of infection. This could, in turn, reduce antibiotic usage in wound care.
17. Antimicrobial dressings alone are not sufficient to disrupt and remove biofilm. They should be used as an adjunct to address residual biofilm and prevent its re-formation. This can only be done if effective wound hygiene is carried out.
18. Biofilm is heterogeneous. Antimicrobial dressings are one part of a strategy for prevening biofilm re-formation. Effective suppression may require alternating antimicrobial dressings. Re-assess dressing choice and make adjustments, as needed, based on the wound's progression towards healing and local availability of dressings.