Improving Outcomes with Better Wound Bed Prep

Here's how to lower infection and amputation rates.

BY JAMES MCGUIRE, DPM AND ZHOU ZHOU, BM, PHD

"The wound is a battle the skin is losing" is a quote from Dr. Jane Fore and perfectly sums up the problem facing both the practitioner and the patient suffering from a chronic wound. To win a battle, the general (you) must know the enemy's strengths and weaknesses, develop a plan to defeat those strengths using the weaknesses discovered, provide your troops with the necessary weapons to remove the enemy from the battlefield, and restore peace to the theater. The process of wound evaluation and treatment is referred to as wound bed prep and includes wound assessment, debridement, bacterial management, stimulation of the healing process, and dressings to maintain a healthy wound environment.[1]

There has been a renewed interest in the topic of wound hygiene. A recent panel that convened to study the subject concluded that wound hygiene is an essential part of good wound healing. Biofilm management is a necessary component of that, and a Step-Down Step-Up approach to wound care proposed by Schultz et al.[2] is the preferred way to manage the war.

Murphy, et al.[1] recommended a four-step approach to the evidence for wound hygiene including: 1) Cleanse the wound and periwound skin; 2) Debride the wound to remove all biofilm and non-viable material; 3) Refashion the wound edges to address overlap, undermining, and keratotic buildup; and 4) Select a dressing appropriate for the wound condition and drainage. The Step-Down Step-Up approach proposed by Schultz, et al.[2] outlined a biofilm-based approach to wound healing and begins with initiating multiple strategies to disrupt, remove, and inhibit reformation of biofilm. This is followed by regular and frequent re-assessment of progress and modification of interventions to optimize wound progression, de-escalating the aggressiveness of those therapies as the wound responds.

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If the wound continues to improve beyond the four-week period with 50% + closure rates, standard care can be continued until the end. If the wound stalls or fails to reach the 50% benchmark by four weeks, clinicians can then step up their treatment to include the many advanced therapies available: growth factors, skin and other tissue-based applications, various combination products, and negative pressure wound therapy.

One of the more difficult components of wound bed assessment is the identification and selection of debridement of what we refer to as 'slough'. Slough is the yellow material spontaneously formed in the wound bed. Even though it is commonly observed in wound care practice, our understanding of slough is still very premature. In 2011, National Pressure Injury Advisory Panel, defined slough as yellow material in a well-perfused wound bed, made of fat and fibrin, with or without infection/inflammation.

However, as we study more about slough, we found it is much more complicated than we thought, and one simple definition is not sufficient to describe it. For example, some slough is loosely layered on the wound bed and very easily removed, while some other slough is very firmly attached and needs meticulous sharp debridement and cleansing techniques to be removed.[3] In contrast, slough may also compromise wound healing by facilitating bacterial growth and biofilm formation and encourage prolongation of an inflammatory state.[4,5] McGuire and Nasser attempted to begin to define slough based on its clinical appearance, limited microbiological information from previous debridements, and handling characteristics in a short paper published in *Wounds* in 2021.[6]

Based on appearance and handling, the categories of Bioslough, Fibroslough, Leukoslough and Necroslough were outlined.

Continued on page 76

Wound Bed Prep (from page 75)

Bioslough

Bioslough is essentially biofilm formed by colonized bacteria on necrotic material in the wound bed. Multiple species of bacteria grow in the bioslough to prolong inflammation and delay wound healing. Bioslough should be managed with topical antiseptic and antimicrobial agents, cleansing, debridement and appropriate absorptive and antimicrobial dressings to manage fluid produced by biofilm in the wound bed (Figure 1).

Fibroslough

Fibroslough, which is often seen with vasculitic wounds, forms by repetitive deposition and breakdown of the wound bed, resulting in the accumulation of collagen and fibrin. Sharp surgical macro-debridement is required, augmented by enzymatic or autolytic micro-debridement and appropriate dressings to remove this slough (Figure 2).

Leukoslough

The third type of slough is Leukoslough, formed in response to exaggerated local inflammation. Continuous recruitment of inflammatory cells to the wound bed forms an easily removed, gelatinous layer that is the hallmark of leukoslough. Gentle mechanical debridement augmented by autolytic dressings is usually sufficient for its removal (Figure 3).

Figure 1: Bioslough

Figure 2: Fibroslough

Biofilm is a frequently encountered, compromising factor in wound management.

Figure 3: Leukoslough

Necroslough

The last type of slough is necroslough. It is necrotic tissue that cannot be classified in any of the above types and is formed by maceration of eschar arising from previously viable tissues. Firmly attached dry eschar is usually left in place until, for various reasons, it separates and frequently begins to drain when it is surgically removed. The soft underlying necrotic material produced by liquefaction necrosis under the surface eschar is necroslough. Staged surgical debridement, augmented by enzymatic removal of residual tissue, is needed to treat this slough (Figure 4).[6]

The composition of slough material has attracted the interest of the International Wound Infection Institute which has established the "Slough Project", led by Drs. Greg Schultz and Lindsay Kalan. They have been charged to answer the questions: 1) What is slough? 2) What does slough look like on a wound bed? 3) What are the major molecular components that comprise slough? 4) What is the relationship between slough and bacterial biofilms? 5) Can we remove slough and biofilms and stimulate healing of a wound? To do this, they have employed a sophisticated molecular analysis that includes proteomics and immunochemistry to identify the molecular composition of slough.

Biofilm

Biofilm is a frequently encountered, compromising factor in wound management. Biofilm-producing bacteria can be found in all wound depths from deep wounds to superficial injuries. Biofilms are present as a thin slime layer without visible bioslough or within or under visible slough. It has also been found on dressing materials used on the wound.[4] Given its therapy-resistant nature and wide distribution in the wound, early intervention with debridement, multiple therapies, and effective antibiofilm antiseptics are the hallmark of a biofilm-based wound care approach.

Biofilm-based wound care is most effective when the wound has no visible biofilm and when it is done frequently on a regular basis. Early implementation of multiple concurrent therapies in combination keeps the bacteria from adapting and forming biofilm. A great deal of money has been wasted on advanced therapies such as growth factors, cellular and acellular tissue-based products, and even skin grafts inappropriately applied to poorly prepared wounds

Continued on page 78

Wound Bed Prep (from page 76)

in hopes that the treatments would override wound bed deficiencies. Preparation is the key to winning a game or a war, and applying expensive wound products to biofilm-laden wounds will ultimately fail.

As the first line of defense against wound infection, wound hygiene is an important component of wound bed management. Wound hygiene should be performed at every dressing change. Cleaning the wound and peri-wound skin is essential to preventing the growth of potential infecting agents and their migration onto the wound bed. The peri-wound consists of the wound edge and the skin 10-20 mm away from wound edge, or the entire area covered by dressing, whichever is larger.[1]

Fluorescence imaging of wounds for detection of elevated bacteria loads (> 104 CFU/g)is now available to clinicians to identify many microorganisms and map their location on the wound and periwound in a point-of-care assessment. This aids in bacterial identification, targeting for selective debridement, and assessment of the efficiency of debridement and cleansing techniques (Figure 5 A/B).[7-11]

Many methods of debridement are available to remove inviable tissue, such as: sharp surgical, mechanical, biological, enzymatic, and autolytic. Care providers need to know the extent of bacterial contamination and the location of colonies on the wound and periwound to select the most appropriate wound debridement tools and wound cleansing and dressing agents.[11] Peri-wound skin cleansing, often skipped in the wound bed prep, is a critical step to reduce the chance of infection by removing colonizing bacteria from around the wound.[9] Routine or diagnostic wound cultures are often discouraged for legal fears and often take several days to get information helpful in choosing the appropriate antibiotic or antiseptic agents. Fluorescent imaging provides real-time information to reduce the time to choose those agents.[9]

Figure 4: Necroslough

Optimizing the healing environment decreases the potential for wound infection. The solution to irrigate the wound should: a) optimize the healing environment and decrease the potential for infection; b) rapidly decontaminate the wound; c) remove necrotic tissue and cellular debris such as bacteria, exudate, and purulent material; d) enhance the effectiveness of other advanced healing modalities, e) prevent the accumulation of competing biofilms; f) loosen and remove residual material from previous dressings.

Traditionally, saline is used as the universal irrigation solution, but recent findings may prompt us to rethink that tradition.

Traditionally, saline is used as the universal irrigation solution, but recent findings may prompt us to rethink that tradition. In 2007, Moscati, et al.[12] performed a multicenter comparison of tap water versus sterile saline for wound irrigation and found that saline had no statistical advantage over tap water against wound infection. In 2020, Ambem, et al.[13] performed a systematic review of four RCTs totaling 1,194 patients and could not identify a reduction in the rate of SSI for routine irrigation of abdominal wounds with normal saline over no irrigation at all prior to wound closure. Wolcott and Fletcher[14] in a paper in *Wounds International* stated that saline was not an appropriate wound cleanser for use in biofilm-based wound care and proposed hypochlorous acid HOCl as an alternative. An expert panel lead by David Armstrong in 2015 recommended HOCl should be used in addition to aggressive debridement, infection control, moisture balance, and edge optimization in diabetic foot ulcers.[15]

These and other findings suggest that saline may not be the best wound cleansing solution in biofilm-based wound care or in a wound that is clinically diagnosed as infected or at risk of local infection. Those findings also

Continued on page 79

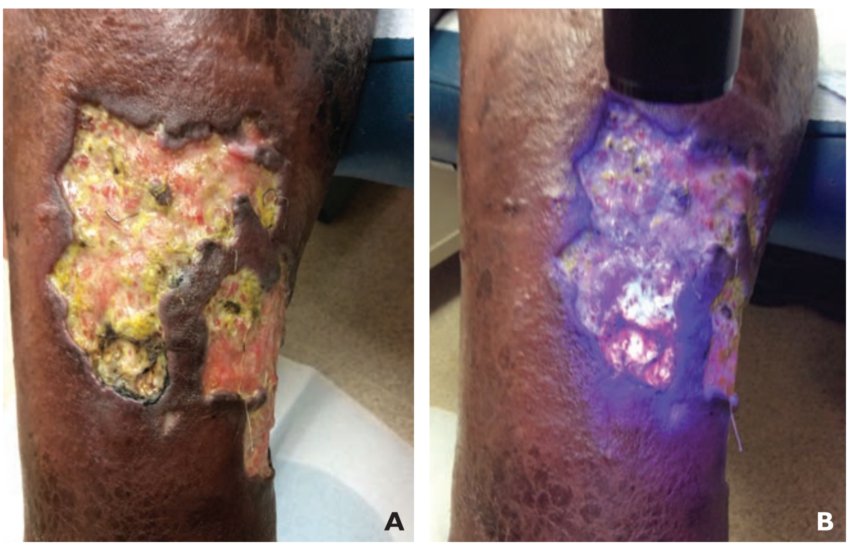

Figure 5 A/B: Fluorescent Imaging of Wound Bacteria

Wound Bed Prep *(from page 78)*

suggest that HOCl is an ideal cleansing solution to replace saline. The articles listed the following criteria for choosing a wound cleansing agent: reduction of bacterial growth, a low incidence of associated post-op complications, rapid kill rates on most common wound pathogens, anti-bacterial, antifungal, and antiviral capability, no tissue toxicity compared to NSS at a Neutral pH 5.5-6.5, biofilm effectiveness, that it be anti- or non-inflammatory, and that it has a positive cost benefit analysis when compared to other agents.[16-21]

Applying the above information, Temple University School of Podiatric Medicine has incorporated HOCl in our wound center protocol:[22]

- ABCESS Medical History
- Observation/Measurement
- Assess Biofilm/Infection Risk
- Culture if Appropriate
- Periwound and Wound Bed Cleansing with HOCl
- Debridement of Nonviable Tissue, Disruption of Biofilm, and Re-animation of the Wound Edge
- Apply 10 Minute HOCl Gauze Soak
- Hydrate Periwound Skin/Limb
- Apply HOCl Hydrogel and an Antimicrobial Contact Layer
- Choose Dressings based on Exudate Production and Biofilm History
- Off-load/Protect/Compress as Needed
- Review Home Care Instructions
- Write Home Care/Nursing Orders to include HOCl

Wound bed prep and effective ongoing bacterial management are the keys to improved wound healing rates, lower infection rates, and lower incidences of infection-related complications such as osteomyelitis and amputation. Early intervention and prevention of infection by halting the progression of wound contamination to local infection are inexpensive interventions that have big long-term benefits for the patients and the health system. **PM**

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