Optimizing the Moisture Management Tightrope with Wound Bed Preparation 2015©

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PURPOSE:
To provide an overview of moisture management and its importance in wound care.

TARGET AUDIENCE:
This continuing education activity is intended for physicians and nurses with an interest in skin and wound care.
OBJECTIVES:
After participating in this educational activity, the participant should be better able to:
1. Summarize causes and treatments for moisture balance issues of chronic wounds.
2. Recognize the properties of dressings used for treatment for moisture management of chronic wounds and antiseptic agent cytotoxicity.
3. Explain study findings of the effectiveness of dressing choices for treatment of chronic wounds.

ABSTRACT
OBJECTIVE: To provide an overview of moisture management and its importance in wound care. The authors evaluate the impact of moisture management for optimal wound care and assess current wound management strategies relating to antiseptic and moist wound management utilizing the wound bed preparation paradigm 2015 update. The discussion distinguishes the form and function of wound care dressing classes available for optimal moisture management.

CONCLUSION: Moisture management for chronic wounds is best achieved with modern moist interactive dressings if the wound has the ability to heal.

KEYWORDS: moisture management, wound healing, antiseptic

INTRODUCTION
A wound (ulcer) is a loss of epidermis with a dermal or deeper base, representing a disruption of skin integrity with tissue damage. Wounds can have vascular, traumatic, inflammatory, infectious, or malignant etiologies. Acute wound healing occurs along a concerted biochemical cascade. A wound can become chronic if the inflammatory or proliferative phases of the cascade stall.1,2 Distinct biochemical differences exist between healing and stalled chronic wounds. In healing wounds, cellular mitosis increases, whereas proinflammatory cytokines and matrix metalloproteinases decrease. In chronic wounds, the reverse process occurs. Following the same pattern, growth factors increase, and cellular response is rapid in healing wounds, whereas growth factor levels are suboptimal and cellular response senescent in chronic wounds.

Chronic wounds are prevalent and cause substantial morbidity, mortality, and increased healthcare costs.3 The wound bed preparation (WBP) paradigm provides a framework for care of chronic wounds, with an emphasis on an interprofessional approach. This article explores the use of WBP in chronic wound care. Moisture management will be discussed, including cleansing, antiseptic, and moist wound healing principles.

MOISTURE MANAGEMENT AND WOUND HEALING
Moisture management and moist wound healing concepts were established by the work of Winter4 in animal models and Hinman and Maibach5 in human models. Moist wound environments enhance wound healing and promote new tissue growth. In contrast, excess or insufficient moisture impairs the healing process and causes breakdown of the wound bed and surrounding skin. These tissue alterations increase the risk of bacterial damage from superficial critical colonization and deep/surrounding wound infection.6 Low moisture levels may also lead to necrosis and eschar formation, hindering wound re-epithelialization and closure. Thus, moisture balance of the wound bed is critical for wound healing.7

THE WOUND BED PREPARATION PARADIGM
Wound Bed Preparation 2015 is a structured approach to wound healing.8-10 Building on previous editions, this WBP paradigm adds healability determination into the comprehensive assessment (Figure 1). This assessment should also identify patient-/family-centered concerns and an accurate diagnosis of wound etiology (ie, the wound cause [see Table 1]). The 3 components of local wound care—debridement, inflammation/infection, and moisture balance management—should be addressed after completing the comprehensive patient assessment, including the division of wounds into healable, maintenance, and nonhealable healing potential categories. The clinician should distinguish:

• healable wounds with adequate blood supply that can be healed if the underlying cause is addressed.

• maintenance wounds have healing potential, but also have patient or health system barriers compromising healing, including patient nonadherence to treatment or healthcare resource limitations.

• nonhealable wounds (including palliative wounds) cannot heal because of irreversible causes or associated illnesses, including critical ischemia or nontreatable malignancy.

In maintenance and nonhealable wounds, a relatively conservative approach should be taken, potentially involving conservative debridement of slough, bacterial reduction through antiseptic, and moisture reduction (Table 2).
In healable wounds (Table 2), there are 3 initial local wound care components that should be addressed:
- **debridement** of necrotic tissue that may include active surgical removal of debris to bleeding tissue;
- **inflammation/infection** recognition and management, followed by topical and systemic therapies as appropriate; and
- **moisture balance** in the wound bed interface.

See Table 2 for a summary of local wound care strategies.

**HEALABLE WOUNDS: AN APPROACH TO MOISTURE-BALANCE DRESSINGS**

Moisture balance at the wound bed interface may be achieved with a variety of dressings (Table 3). There are 5 major choices of antimicrobial dressings (silver, polyhexamethylenebiguanide [PHMB], iodine, methylene blue/crystal violet, and honey), with 2 of these choices having anti-inflammatory properties (silver, honey). Moisture-balance dressing classes are often combined with antibacterial and anti-inflammatory dressings in healable wounds to manage inflammation/infection according to the clinical characteristics of the wound. Validated tools that may be utilized to diagnose wound infection/inflammation before using these dressings include the “NERDS” and “STONEES” criteria and SIBBALD cubes.6,11 (Figure 2).
Using the NERDS mnemonic, if 3 or more are present, treat topically:
- Nonhealing wounds
- Exudative wounds
- Red and bleeding wound surface granulation tissue
- Debris (yellow or black necrotic tissue) on the wound surface
- Smell or unpleasant odor from the wound

Using the STONEES mnemonic, if 3 or more are present, treat systemically:
- Size is bigger
- Temperature of 3°C F or more versus mirror image
- Os (probe to or exposed bone)
- New or satellite areas of breakdown
- Exudate is increased

### Table 2.
**SUMMARY OF LOCAL WOUND CARE STRATEGIES BY WOUND HEALABILITY CLASSIFICATION**

<table>
<thead>
<tr>
<th>Wound Healability Classification</th>
<th>Surgical Debridement</th>
<th>Inflammation/Infection Management</th>
<th>Moisture Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Healable</td>
<td>Active</td>
<td>Treat inflammation/infection (topically or systemic) + antisepsis as required</td>
<td>Moisture balance</td>
</tr>
<tr>
<td>Maintenance</td>
<td>Conservative (no bleeding)</td>
<td>Bacterial reduction—antisepsis</td>
<td>Moisture reduction</td>
</tr>
<tr>
<td>Nonhealable</td>
<td>Comfort removal of slough</td>
<td>Bacterial reduction—antisepsis</td>
<td>Moisture reduction</td>
</tr>
</tbody>
</table>

### Table 3.
**SUMMARY OF MODERN DRESSING CATEGORIES ORDERED BY INCREASING ABSORBENCY**

<table>
<thead>
<tr>
<th>Modern Dressing Category</th>
<th>Comment</th>
<th>Average Wear Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrogels</td>
<td>Contain 70%-90% moisture</td>
<td>1–3 d</td>
</tr>
<tr>
<td>Donate moisture</td>
<td>Donates moisture to the wound</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bioreresorbable</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Can be combined with silver, iodine (cadexomer) for antimicrobial action</td>
<td></td>
</tr>
<tr>
<td>Films</td>
<td>Protective layer</td>
<td>3–7 d</td>
</tr>
<tr>
<td>Moisture neutral</td>
<td>Does not donate or absorb a large amount of exudate</td>
<td></td>
</tr>
<tr>
<td>Hydrocolloids</td>
<td>Water-binding and water-repelling components</td>
<td>2–7 d</td>
</tr>
<tr>
<td>Hydrofibers</td>
<td>Bind small to moderate amount of exudate</td>
<td>1–3 d</td>
</tr>
<tr>
<td></td>
<td>Fluid lock, nonbioresorbable</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Can be combined with silver for antimicrobial action</td>
<td></td>
</tr>
<tr>
<td>Calcium alginites</td>
<td>Absorb small to moderate amounts of exudate onto outer surface of dressing</td>
<td>1–3 d</td>
</tr>
<tr>
<td></td>
<td>Fibers are bioresorbable, releasing calcium (hemostasis property) and resorbing sodium to form a hydrogel with exudate fluid</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Can be combined with silver and for antibacterial action</td>
<td></td>
</tr>
<tr>
<td>Foams</td>
<td>Absorb moderate amounts of exudate</td>
<td>2–7 d</td>
</tr>
<tr>
<td></td>
<td>Fluid balance with the dressing giving back some exudate that prevents wound surface from dehydrating</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Can be a method of delivering an antibacterial agent (silver) or containing a nonrelease antibacterial agent for antibacterial action above the wound surface (PHMB, methylene blue/gentian violet)</td>
<td></td>
</tr>
<tr>
<td>Superabsorbents</td>
<td>Absorb a larger amount of exudate</td>
<td>1–3 d</td>
</tr>
<tr>
<td></td>
<td>Fluid lock technology equivalent to diapers</td>
<td></td>
</tr>
</tbody>
</table>

*Also provides autolytic debridement properties.
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Moisture-Balance Dressings

The Cochrane reviews (Table 4) state there is often no current evidence to support the effectiveness of many of these dressings over a comparator dressing or standard wound care. Yet, modern moist interactive dressings can offer several advantages. Gauze dressings, for example, need frequent changes (1–3 times per day). This can result in intensive demand for nursing care. Furthermore, gauze dressings are associated with increased patient pain and potential for wound trauma upon removal. Although gauze is relatively inexpensive, the costs of nursing services and patient time required for frequent changes can sometimes make gauze less cost-effective than most modern dressings, particularly when these dressings are used appropriately.

The following sections (Table 3) will discuss moisture-balance dressing categories. Particular attention will be given to chemical composition, form, function, and clinical application.

Hydrogels

Hydrogel (ie, hydrated polymer) dressings have a high water content (60%–90%). Hydrogels are capable of providing moisture. This feature aids the autolytic debridement of sloughy or necrotic wound tissue. Hydrogels are clear or translucent, vary in viscosity, and are available in 3 forms: amorphous (most common), impregnated gauze, and as a wafer. In clinical settings, the high water content can lead to periwound maceration. To prevent this moisture-associated damage, a periwound barrier should be applied after wound cleansing (saline or water preferred). Four barriers are available: using film-forming liquid acrylate spray or wipe, zinc oxide ointment, petrolatum, or a windowed occlusive dressing (film or hydrocolloid).

Films

Film dressings are transparent polyurethane dressings with or without adhesives. They are often used for local protection of a wound at the late re-epithelialization stage or to protect a recently healed wound. The choice of a nonadherent versus a film dressing

Moisture-Balance Dressings

Table 3

<table>
<thead>
<tr>
<th>Condition</th>
<th>Category</th>
<th>Dressing Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>High bacteria ≥ 3 NERDS</td>
<td>High proteases</td>
<td>Anti-inflammatory + Antimicrobial dressing</td>
</tr>
<tr>
<td>Low bacteria &lt; 3 NERDS</td>
<td>Low proteases</td>
<td>Moisture-balance dressing</td>
</tr>
</tbody>
</table>

Figure 2.
SIBBALD CUBE

Sibbald Cube®

- Use in the Heavily Wound that is “stalled”. (Less than 30% decrease in size in 4 weeks)
- Correct & modify cofactors using Wound Bed Preparation®

*Test to detect high surface MMPs or based on clinical criteria

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<table>
<thead>
<tr>
<th>Dressing(s)</th>
<th>Brief Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alginates: diabetic neuropathic/neuroischemic/ischemic foot ulcers</td>
<td>A 2013 Cochrane review investigated alginate dressings for healing diabetic neuropathic/ischemic/neuroischemic foot ulcers. It included 6 studies (n = 375) that compared alginate dressings with basic wound contact dressings, foam dressings, and silver-containing, fibrous-hydrocolloid dressings. Conclusion: No evidence found to suggest alginate wound dressings are more effective at healing diabetic foot ulcers than other dressings. Small sample size merits caution.</td>
</tr>
<tr>
<td>Alginates: in pressure ulcers</td>
<td>A 2015 Cochrane review investigates alginate dressings for healing pressure ulcers. It included 6 studies (n = 336) that compared alginate dressings with hydrocolloid dressings, silver-containing alginate dressings, and radiant heat therapy. Conclusion: The relative effects of alginate dressings compared with alternative treatments are unclear.</td>
</tr>
<tr>
<td>Alginates: chronic ulcers in older adults (&gt;65 y)</td>
<td>A 2015 Canadian Health Technology Assessment (HTA) investigated prevention and treatment of chronic ulcers in the older adults.</td>
</tr>
<tr>
<td>Alginates and films: split-thickness skin grafts</td>
<td>A 2013 randomized controlled trial (RCT) (n = 38) by Läuchli et al compared calcium alginate dressings vs polyurethane film dressing for split-thickness skin graft donor sites. Conclusion: Film dressings resulted in initial lower pain scores, whereas alginate dressings were found to cause fewer additional dressing changes and less leakage.</td>
</tr>
<tr>
<td>Foams: diabetic neuropathic/neuroischemic/ischemic foot ulcers</td>
<td>A 2013 Cochrane review investigated foam dressings for healing diabetic foot ulcers; included 6 studies (n = 157) that compared foam dressings with basic wound dressings. Conclusion: No evidence found to suggest foam wound dressings are more effective in healing diabetic foot ulcers than other dressings. Small sample size merits caution.</td>
</tr>
<tr>
<td>Foams: venous leg ulcers</td>
<td>A 2013 Cochrane review investigated foam dressings for venous leg ulcers. It included 12 studies (n = 1023) that evaluated the effects of any type of foam dressing in the treatment of venous ulcers. Conclusion: The current evidence base does not suggest that foam dressings are more effective in the healing of venous leg ulcers than other wound dressing treatments.</td>
</tr>
<tr>
<td>Hydrocolloids: diabetic neuropathic/neuroischemic/ischemic foot ulcers</td>
<td>A 2013 Cochrane review investigated hydrocolloids for healing diabetic foot ulcers. It included 5 studies (n = 535) that compared hydrocolloid dressings with basic wound contact dressings, foams, silver, and a topical cream containing plant extracts. Conclusion: No evidence found to suggest that any type of hydrocolloid wound dressing is more effective in healing diabetic foot ulcers than other types of dressing or a topical cream containing plant extracts. Small sample size merits caution.</td>
</tr>
<tr>
<td>Hydrocolloids: nonadherent vs traditional dressings for wounds in general</td>
<td>A 2011 Canadian HTA investigated hydrocolloid vs traditional dressings. It reviewed 1 relevant HTA report, 3 relevant systematic reviews, and 7 relevant evidence-based guidelines. Conclusion:</td>
</tr>
<tr>
<td>Hydrofibers and alginates for nonischemic diabetic foot ulcers</td>
<td>A 2007 prospective RCT (n = 67) by Jude et al compared hydrofiber dressing containing ionic silver vs calcium alginate dressings in nonischemic diabetic foot ulcers. Conclusion: When added to standard care with appropriate off-loading, hydrofiber dressings containing ionic silver were associated with favorable clinical outcomes compared with calcium alginates, specifically in ulcer depth reduction and in infected ulcers requiring antibiotic treatment. (Note that the hydrofiber had silver, and the comparator calcium alginate did not.) (continues)</td>
</tr>
</tbody>
</table>
with adhesive backing is partly determined by the fragility of the surrounding skin. Film dressings with acrylic adhesives can cause skin tears in contrast to silicone-coated films that decrease pain and trauma with dressing removal. Film materials are semi-occlusive, have relatively no absorptive capacity, and have a varying degree of permeability (referred to as the moisture vapor transmission rate) that allow for differential evaporation of the water molecules through the dressing. Remove acrylic adhesives by gently pulling laterally in a repeated clockwise rotation.

**Hydrocolloids**

Hydrocolloids are most commonly available in a wafer type of occlusive dressing that consist of gel-forming agents (containing carboxymethylcellulose) with a flexible, water-resistant outer layer. The dressings have an adhesive and come in a variety of shapes designed for body areas, including the sacrum and heels. Hydrocolloid dressings are mildly absorptive and have a wear time equivalent to foam dressings (up to 7 days) but longer than most other dressing classes. For application of hydrocolloid dressings, the wound margin should be overlapped by 1 to 2 cm to form an adhesive seal. This overlap also prevents exudate leakage from the edges of the dressing. When these dressings are used for autolytic debridement, they may need to be changed more frequently. Removal of nonviable slough from the surface of the wound may also be required at dressing change to prevent odor or secondary bacterial proliferation under the dressing.

**Hydrofibers**

Hydrofiber dressings consist of carboxymethylcellulose spun into a fiber format instead of the gelled form in hydrocolloid dressings. The fiber gives the dressing tensile strength, and it can usually be removed easily in 1 piece. As the spun hydrofibers bind exudate with interior fluid lock, the dressing promotes very little autolytic debriding. As the dressing absorbs fluid, the hydrofibers are converted into a gel. Hydrofiber dressings are thin and have low to moderate absorbency, although thicker newer dressing options have increased absorbency. These dressings need a secondary dressing to keep them in place because the addition of an adhesive will interfere with the fluid absorption properties of the dressing.
Calcium Alginates
Calcium alginates are nonwoven biodegradable fibers processed from acids derived from brown seaweed. When calcium alginates bind fluid in a wound, the calcium ions are donated to the wound surface, and the absorbed sodium results in the formation of a soluble hydrogel. Calcium alginate dressings are able to absorb up to 20 times their weight in fluid. Once in gel form, the dressings can promote autolytic debridement of the wound. Uniquely to calcium alginate dressings, release of calcium ions into the wound bed can also help in hemostasis without the formation of hemorrhagic crust on the wound surface. These dressings are manufactured in sheets (lateral fluid wicking) or in ropes (vertical fluid wicking) and can readily conform to wounds of varying shapes. Alginate dressings are bioresorbable and need a secondary dressing with similar application principles for hydrogels or hydrofibers. If any alginate fibers are left intact at dressing change, they can be moistened to dissolve and do not have to be removed mechanically. If the fibers remain dry, a water-donating hydrogel may be a better dressing choice.

Foams
Foam dressings are manufactured most commonly as polyurethane foams. These dressings absorb a moderate to large amount of exudate. Foam dressings can consist of 2 to 3 layers with a hydrophilic contact surface between the foam and a hydrophobic backing. Foam dressings are manufactured with normal absorbency, light or less absorptive dressings, with and without adhesives or borders. The silicone adhesive format has demonstrated decreased pain on dressing removal compared with the more traditional acrylic adhesives. Exudate absorbs into hollow polyurethane pores, creates equilibrium, and donates moisture back to the wound with increasing saturation to achieve a fluid balance. The fluid exchange function can lead to periwound maceration. Some of the more advanced foams have variable pore sizes that lead to partial fluid retention in addition to the traditional fluid exchange functions. Periwound maceration can also be minimized if a periwound barrier is applied, and the foam is cut to the wound size, fenestrated on the top to wick to a secondary superabsorbent dressing, or changed more frequently. An alternate foam core with polyvinyl alcohol can provide autolytic debridement not provided by the traditional polyurethane core. Foams have also been combined with antiseptics (eg, silver, PFKMB, methylene blue/crystal violet) and other agents to serve as a delivery vehicle for active therapies at the wound surface.

Superabsorbents
Superabsorbent polymer–containing wound dressings are best suited to manage highly exudative wounds. These dressings can absorb an enormous amount of water relative to their dry weights. Superabsorbent polymers are the same technology utilized in diapers, feminine hygiene materials, and adult incontinence products. Superabsorbent dressings are typically manufactured from acrylic acid. They undergo polymerization by suspension or cross-linking, which accounts for their absorptive and protein-binding properties (ie, proteases). They have multiple layers, a large absorbent surface, a fluid lock to prevent periwound maceration, and a contact layer that protects the wound base from the inner core that can become saturated with wound exudate. The core fluid locking materials may include powders, crystals, or gelling agents that work by osmosis, with fibers having a capillary-like action. Secondary dressings are necessary for fixation to the surface of the wound if there is no adhesive.

Recent Literature on Moisture Balance Dressings
The authors searched The Cochrane Library, Ovid MEDLINE, University of York Centre for Reviews and Dissemination database, and Google Scholar for systematic reviews, health technology assessments, and high-quality randomized controlled trials published from January 2007 to June 2015. The terms “foam,” “superabsorbent,” “calcium alginate,” “hydrogel,” “acrylate,” “hydrocolloid,” or “film” and word variations of these were searched. The authors used the GRADE system to assess the quality of articles. Hand referencing was also utilized. The results of the literature review are displayed in Table 4. Most dressing versus dressing comparisons did not yield definitive conclusions. However, some exceptions exist, including the following:

- hydrogels over basic contact wound dressings for diabetic foot ulcers
- hydrogels over gauze or standard care for debridement of diabetic foot ulcers
- hydrofiber dressing containing ionic silver over calcium alginate dressings in nonischemic diabetic foot ulcers (the comparator was not equal because it did not contain silver)
- calcium alginate dressing over other comparator treatments for pressure ulcers (PrUs) in older adults
- hydrocolloid dressings over other comparator treatments for venous leg and pressure ulcers
- autolytic (hydrogel) and enzymatic debridement (clostridial collagenase ointment) for debridement of diabetic foot ulcers over standard wound care
- calcium alginate over polyurethane film dressing for split-thickness skin graft donor sites.

Wound Cleansing
The goal of wound cleansing is to promote healing through improved wound assessment, increased comfort with adherent dressing removal, and possible rehydration of the wound bed. Antiseptics have been used as wound cleansing agents for decades,
but questioned in recent years because of a paucity of evidence for their use. The standard care of wound cleansing is to use solutions that are as gentle and noncytotoxic to the wound as possible, such as saline, water, or acetic acid (0.5%–1.0%). A compress is when these solutions are applied to gauze, and the excess is rung out before application. The result is a net movement of fluid from the wound surface to the gauze via astringent (coagulate protein) action. A soak uses the same procedure of saturating gauze, but the gauze is then applied saturated, resulting in a net fluid movement into a dry wound surface from the gauze.

An updated Cochrane Collaboration review in 2013 for cleansing PrUs concluded, “There is no good trial evidence to support use of any particular wound cleansing solution or technique for pressure ulcers.” These same principles apply to irrigation. This technique can cause more harm than benefit if the force applied causes more pain or tissue damage. If the bottom of the wound is not visualized, irrigation fluid remains behind, it may also form the nidus for bacterial abscess.

MAINTENANCE AND NONHEALING WOUNDS

A conservative approach should be taken for the management of wounds with compromised healing potential. The focus should be placed on patient-concerned concerns, especially pain and optimizing activities of daily living. Antiseptics are frequently used for the purposes of moisture reduction and control of bacterial burden. As with healable wounds, solutions with minimal potential for cytotoxicity should be utilized. Some antiseptic solutions are more cytotoxic to fibroblasts than other solutions, and although toxicity is often less in vivo, the impact may be increased in nonhealing wounds.

Most antiseptics are bactericidal with a broad spectrum of action. They often have many targets, including cell walls, cell membranes, cytoplasmic organelles, and DNA. Bacterial resistance of antiseptics is very low, and their use is preferred topically compared with topical antibiotics. Topical antibiotic use should be generally avoided to lower the risk of bacterial resistance and adverse effects. For maintenance and nonhealing wounds, systemic antibiotics are reserved for deep and surrounding infections.

In an area of inadequate blood supply or uncontrolled edema (eg, congestive heart failure, refractory venous disease), moisture reduction and the use of topical antisepsis with or without a secondary dressing may be beneficial. For example, in persons with distal gangrene, antiseptic agents with low toxicity may be used, including 10% povidone-iodine, chlorhexidine, or its derivative PHMB. The agents are best applied around the proximal edges of the gangrene to decrease the risk of infection and prevent tissue breakdown at the edge between the gangrenous and viable tissue.

Active or aggressive debridement that creates bleeding is not recommended in maintenance and nonhealing wounds. The reason is that aggressive debridement further compromises tissue, leading to potential deep infection. For example, in diabetic neurotropic foot ulcers with inadequate vascular supply, active debridement leads to bleeding, further callus formation, and an expanding ulcer. Conservative debridement with callus removal followed by local wound care as previously discussed is recommended. Similarly, in PrUs without healing potential, the same wound care principles are recommended, along with application of strategies to minimize pressure and shear forces.

Table 5 lists the common antiseptics in ascending order of tissue toxicity. Although the “red” agents have increased potential for cytotoxicity, they may be useful in specific circumstances.

Chlorhexidine, PHMB, and povidone-iodine have their antibacterial activity by attacking bacterial cell walls, cytoplasmic organelles, or nucleic acids. Dilute acetic acid (0.5%–1%) lowers the surface pH of wounds. This has antipseudomonal activity as Pseudomonas species grow best in alkaline pH environments. White vinegar (5% acetic acid) can be diluted 1:5 to 1:10 with potable or sterile water and applied locally as an alternating compress. Gauze can be moistened with the acetic acid and squeezed to remove excess moisture. The gauze is then placed on the wound for 30 to 60 seconds and discarded. A second gauze application follows for 5 to 10 minutes. Although Pseudomonas aeruginosa can often be found in chronic wounds, guidelines have increasingly suggested it seldom requires systemic treatment in the absence of deep and surrounding Pseudomonas predominant infection.

Antiseptics with high potential for cytotoxicity include dyes, bleaches, hydrogen peroxide, and quaternary ammonium compounds. Dyes including agents such as scarlet red and mercuriochrome

Table 5.
SELECT ANTISEPTIC AGENTS LISTED BY INCREASING CYTOTOXICITY

<table>
<thead>
<tr>
<th>Agent</th>
<th>Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chlorhexide or PHMB</td>
<td>Low toxicity</td>
</tr>
<tr>
<td>Povidone-iodine (Betadine)</td>
<td>Broad spectrum</td>
</tr>
<tr>
<td>Acetic acid—vinegar diluted 1:5 to 1:10</td>
<td>Pseudomonas</td>
</tr>
<tr>
<td>Saline/sterile water</td>
<td>Not antibacterial</td>
</tr>
<tr>
<td>Dyes—scarlet red, proflavine</td>
<td>Select out gram negative</td>
</tr>
<tr>
<td>Sodium hypochlorite—Dakin</td>
<td>Toxic = bleach</td>
</tr>
<tr>
<td>solution. EUSOL</td>
<td></td>
</tr>
<tr>
<td>Hydrogen peroxide</td>
<td>Action = fizz</td>
</tr>
<tr>
<td>Quaternary ammonia—cetrimide</td>
<td>Very high toxicity</td>
</tr>
</tbody>
</table>

Agents are color coded by safety profile and antiseptic action: green = low toxicity potential, yellow = no antibacterial effect, red = high toxicity potential.
are more active against gram-positive than gram-negative bacteria. Bleach (sodium hypochlorite) is an excellent external environmental agent, often used to decrease bacterial contamination on working surfaces and objects. Bleach is also prepared as Dakin solution or Edinburgh University solution of lime (EUSOL).

Patients with extensive wounds and adherent, difficult-to-remove dressings can be clinically challenging. Soaking each individual wound for 5 to 10 minutes or removing the dressings in the bathtub may help reduce dressing removal pain and trauma. A dilute acetic solution will acidify water and help decrease bacteria. Bleach (5–10 mL in 5 L) with acidification releases hypochlorous acid and also acts as an astringent to coagulate protein. These processes may decrease the bacterial burden and be beneficial if used sparingly.34

Hydrogen peroxide has a broad range of activity, with a short period of antibacterial action on the skin. It is active only when fizzing and is associated with air emboli if used in deep cavities.35 Lastly, quaternary ammonium compounds have detergent-like actions with a broad antimicrobial activity but have a higher level of tissue toxicity than other agents. Therefore, quaternary ammonium compounds are not a recommended agent in wound management.

**SUMMARY**

Moisture management for chronic wounds is best achieved with modern moist interactive dressings if the wound has the ability to heal. For nonhealable or maintenance wounds, moisture reduction, bacterial reduction, and conservative debridement of slough are recommended. Each patient must be considered individually, and wounds assessed for pain, local wound fragility, and tissue viability in order to make the best choice for local wound care utilizing the WBP paradigm.

**PRACTICE PEARLS**

- All chronic wounds should be classified as healable, nonhealable, or maintenance.
- Moisture-balance dressings are important for healable wounds, with moisture reduction often more appropriate for nonhealable or maintenance wounds.
- Sharp surgical debridement is appropriate for healable wounds, with conservative surgical debridement of slough more important for the nonhealable and maintenance wound.
- Critically colonized wounds (≥3 NERDS criteria) require antimicrobial dressings, with deep and surrounding infections (≥3 STONEES criteria) most appropriately treated with systemic antimicrobial agents.
- There is very little scientific evidence for wound cleansing, and each patient should be evaluated to ensure the technique results in more benefits than the amount of associated pain, or tissue damage, including retained fluid in deep cavities.

**REFERENCES**

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