Optimizing the Moisture Management Tightrope with Wound Bed Preparation 2015©

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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 antisepsis and moist wound healing 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.

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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, antisepsis, and moist wound healing principles.

Moisture management and wound healing

Moisture management and moist wound healing concepts were established by the work of Winter[4] in animal models and Hinman and Maibach[5] 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 V debridement, inflammation/infection, and moisture balance management V should be addressed after completing the comprehensive patient assessment, including the division of wounds into healable, maintenance, and non-healable 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.
- Non-healable wounds (including pallia-tive wounds) cannot heal

because of irreversible causes or associated illnesses, including critical ischemia or non-treatable malignancy.

In maintenance and non-healable wounds, a relatively conservative approach should be taken, potentially involving conservative debridement of slough, bacterial reduction through antisepsis, 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- F or more versus mirror image

Table 1: Treatment of the cause for selected common chronic wounds

Wound Type	Treatment of the Cause
Venous ulcers	• Bandages for healing • Stockings to prevent recurrence
Pressure ulcers	• Redistribute pressure (relieve heel pressure) • Promote physical activity as tolerated • Manage incontinence and moisture • Reduce shear • Enhance and optimize nutrition
Diabetic (neurotrophic) foot ulcers *Callus = pressure* *Blister = friction and shear*	• Vascular: ensure adequate vascular supply • Infection: control superficial critical colonization/deep + surrounding infection • Redistribute plantar pressure

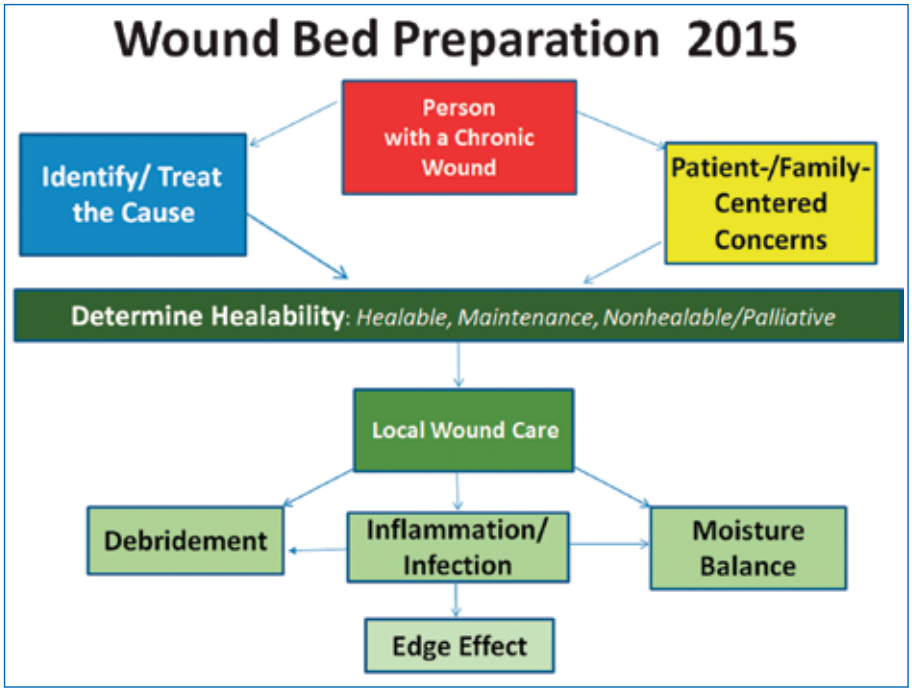

Figure 1: Wound bed preparation paradigm 2015

Figure 2: Sibbald cube

Table 2: Summary of local wound care strategies by wound healability classification

Wound Healability Classification	Surgical Debridement	Inflammation/Infection Management	Moisture Management
Healable	Active	Treat inflammation/infection (topically or systemic) + antisepsis as required	Moisture balance
Maintenance	Conservative (no bleeding)	Bacterial reduction - antisepsis	Moisture reduction
Nonhealable	Comfort removal of slough	Bacterial reduction - antisepsis	Moisture reduction

Table 3: Summary of modern dressing categories ordered by increasing absorbency

Modern Dressing Category	Comment	Average Wear Time
Hydrogelsa	Contain 70%-90% moisture	1–3 d
Donate moisture	Donates moisture to the wound Bioresorbable Can be combined with silver, iodine (cadexomer) for antimicrobial action	
Films[a]	Protective layer	3–7 d
Moisture neutral	Does not donate or absorb a large amount of exudate	
Hydrocolloids[a]	Water-binding and water-repelling components Will absorb small to moderate amount of moisture	2–7 d
Hydrofibers	Bind small to moderate amount of exudate Fluid lock, nonbioresorbable Can be combined with silver for antimicrobial action	1–3 d
Calcium alginates[a]	Absorb small to moderate amounts of exudate onto outer surface of dressing Fibers are bioresorbable, releasing calcium (hemostasis property) and resorbing sodium to form a hydrogel with exudate fluid Can be combined with silver and honey for antibacterial action	1–3 d
Foams	Absorb moderate amounts of exudate Fluid balance with the dressing giving back some exudate that prevents wound surface from dehydrating 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)	2–7 d
Superabsorbents	Absorb a larger amount of exudate Fluid lock technology equivalent to diapers	1–3 d

[a] Also provides autolytic debridement properties.

Os (probe to or exposed bone)
New or satellite areas of breakdown
Exudate is increased
Erythema and/or edema (cellulitis)
Smell

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.[12] 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 highwater 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 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

Table 4: summary of recent literature on moist balance dressings

Dressing(s)	Brief Summary[a]
Alginates: diabetic neuropathic neuroischemic/ ischemic foot ulcers	A 2013 Cochrane review investigated alginate dressings for healing diabetic neuropathic/ischemic/neuroischemic foot ulcers.[25] 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.
Alginates: in pressure ulcers	A 2015 Cochrane review investigates alginate dressings for healing pressure ulcers.[26] 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.
Alginates: chronic ulcers in older adults (>65 y)	A 2015 Canadian Health Technology Assessment (HTA) investigated prevention and treatment of chronic ulcers in the older adults.[21] **Conclusion: Dressings containing calcium alginate may lead to shorter healing time of pressure ulcers in older adults.** It also concluded healing effects of other dressings in this specific age group are insufficiently studied.
Alginates and films: split-thickness skin grafts	A 2013 randomized controlled trial (RCT) (n = 38) by Läuchli et al[24] 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.**
Foams: diabetic neuropathic neuroischemic/ ischemic foot ulcers	A 2013 Cochrane review investigated foam dressings for healing diabetic foot ulcers[27]; 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.
Foams: venous leg ulcers	A 2013 Cochrane review investigated foam dressings for venous leg ulcers.[28] 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.
Hydrocolloids: diabetic neuropathic neuroischemic/ ischemic foot ulcers	A 2013 Cochrane review investigated hydrocolloids for healing diabetic foot ulcers.[29] 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.
Hydrocolloids: nonadherent vs traditional dressings for wounds in general	A 2011 Canadian HTA investigated hydrocolloid vs traditional dressings.[22] It reviewed 1 relevant HTA report, 3 relevant systematic reviews, and 7 relevant evidence-based guidelines. **Conclusion:** Evidence suggests that hydrocolloid dressings may be clinically effective for venous leg and pressure ulcers. Several guidelines recommend nonadherent dressings for venous leg and pressure ulcers, amputations, and chronic wounds.
Hydrofibers and alginates for nonischemic diabetic foot ulcers	A 2007 prospective RCT (n = 67) by Jude et al[20] 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.)
Hydrogels for pressure ulcers	A 2015 Cochrane review investigated hydrogel dressings for healing pressure ulcers.[30] It included 11 studies (n = 523) that compared hydrogel dressings with alternative dressings or no dressings for pressure ulcers Stage II or higher. **Conclusion:** It is not clear if hydrogel dressings are more or less effective than other treatments in healing pressure ulcers or if different hydrogels have different effects.
Hydrogels: neurotrophic/ neuroischemic/ischemic diabetic foot ulcers	A 2013 Cochrane review investigated hydrogel dressings for healing diabetic foot ulcers.[18] It included 5 studies (n = 446) that compared hydrogel dressings with alternative dressings or no dressings. **Conclusion: There is some evidence to suggest that hydrogel dressings are more effective in healing (lower grade) diabetic foot ulcers than basic wound contact dressings.** There is no evidence to suggest that hydrogels are more effective than larval therapy or platelet-derived growth factors in healing diabetic foot ulcers, nor that 1 brand of hydrogel is more effective than another in ulcer healing.
Hydrogels for debridement of neurotrophic/ neuroischemic/ischemic diabetic foot ulcers	A 2010 Cochrane review investigated hydrogels for debridement of diabetic foot ulcers.[19] It included 6 RCTs comparing hydrogel with gauze or standard care. **Conclusion: There is evidence to suggest that hydrogels increase the healing rate of diabetic foot ulcers compared with gauze dressings or standard care.**
Hydrogels: diabetic foot ulcer - no mention of subtypes	A 2014 Canadian HTA investigated debridement procedures for diabetic foot ulcers.[23] It reviewed 12 relevant studies and 7 guidelines. **Conclusion: Autolytic (hydrogel) debridement and enzymatic debridement (clostridial collagenase ointment) are more clinically effective for wound debridement procedures for the treatment of diabetic foot ulcers than standard wound care.**

[a] Positive conclusions are in bold font.

trauma with dressing removal. Film materials are semiocclusive, 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 formin 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 as 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.[12] 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, PHMB, 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.[13] 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.[14] Superabsorbent dressings are typically manufactured from acrylic acid. They undergo polymerization by suspension or crosslinking, which accounts for their absorptive and protein-binding properties (ie, proteases).[15,16] 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.[17] 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[18]
- hydrogels over gauze or standard care for debridement of diabetic foot ulcers[19]
- hydrofiber dressing containing ionic silver over calcium alginate dressings in nonischemic diabetic foot ulcers[20] (the comparator was not equal because it did not contain silver)
- calciumalginate dressing over other comparator treatments for pressure ulcers (PrUs) in older adults[21]
- hydrocolloid dressings over other comparator treatments for venous leg and pressure ulcers[22]
- autolytic (hydrogel) and enzymatic debridement (clostridial collagenase ointment) for debridement of diabetic foot ulcers over standard wound care[23]
- calcium alginate over polyurethane film dressing for split-thickness skin graft donor sites.[24]

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 of care for 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%).[10] 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."[31] 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, and 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.[32] 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 10minutes. 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.[33]

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

Table 5: select antiseptic agents listed by increasing cytotoxicity

Agent	Effects
Chlorhexidine or PHMB	Low toxicity
Povidone-iodine (Betadine)	Broad spectrum
Acetic acid - vinegar diluted 1:5 to 1:10	*Pseudomona*
Saline/sterile water	Not antibacterial
Dyes - scarlet red, proflavine	Select out gram negative
Sodium hypochlorite – Dakin solution, EUSOL	Toxic = bleach
Hydrogen peroxide	Action = fizz
Quaternary ammonia - cetrimide	Very high toxicity

Agents are color coded by safety profile and antiseptic action: green = low toxicity potential, yellow = no antibacterial effect, red = high toxicity potential.

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 compound shave 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 (Q3 NERDS criteria) require antimicrobial dressings, with deep and surrounding infections (Q3 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.

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