Basic principles of wound management

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INTRODUCTION

A wound is a disruption of the normal structure and function of the skin and soft tissue architecture [1]. An acute wound demonstrates normal physiology, and healing is anticipated to progress through the expected stages of wound healing, whereas a chronic wound is broadly defined as one that is physiologically impaired [2,3].

To ensure proper healing through the expected stages, the wound base should be well vascularized, free of devitalized tissue, clear of infection, and moist. Wound dressings might help facilitate this process if they eliminate dead space, control exudate, prevent bacterial overgrowth, ensure proper fluid balance, demonstrate cost-efficiency, and are manageable for the patient and/or nursing staff. Wounds with progressive healing as evidenced by granulation tissue and epithelialization can undergo closure or coverage. All wounds are colonized with microbes; however, not all wounds are infected [4,5].

Many topical agents and alternative therapies are available that are intended to improve the wound healing environment and, although data are lacking to support any definitive recommendations, some may be useful under specific circumstances [6,7].

The basic principles and available options for the management of various wounds will be reviewed. The efficacy of wound management strategies for the treatment of specific wounds is discussed in individual topic reviews:

- (See "Management of diabetic foot ulcers".)

- (See "Evaluation and management of chronic venous insufficiency including venous leg ulcer".)
- (See "Clinical staging and general management of pressure-induced skin and soft tissue injury".)
- (See "Management of chronic limb-threatening ischemia".)
- (See "Overview of inpatient management of the adult trauma patient", section on 'Introduction'.)

MEDICAL CARE

Role of antibiotics — All wounds are expected to be colonized with microbes; however, this does not assume or indicate the presence of an acute infectious process [4,5]. Thus, antibiotic therapy is not indicated for all wounds and should be reserved for only those wounds that appear clinically infected [8]. There is no published evidence to support antibiotic therapy as "prophylaxis" in noninfected chronic wounds, or to improve the healing potential of wounds without clinical evidence of infection. Clinical signs of wound infection that might warrant antibiotic therapy include local (cellulitis, lymphangitic streaking, purulence, malodor, wet gangrene, osteomyelitis) and systemic (fever, chills, nausea, hypotension, hyperglycemia, leukocytosis, change in mental status) symptoms [9,10]. (See "Evaluation and management of suspected sepsis and septic shock in adults" and "Acute cellulitis and erysipelas in adults: Treatment".)

Glycemic control — Most clinicians make glycemic control a priority when treating wounds, although there is no robust clinical evidence in support of short-term glycemic control as directly affecting wound healing potential [11,12]. However, clinical studies suggest that intensive glycemic control can reduce incidence of diabetic foot ulceration by approximately 23 percent [13]. (See "Susceptibility to infections in persons with diabetes mellitus".)

Patients at risk for the development of chronic wounds often have comorbid conditions associated with immunocompromised states (eg, diabetes) and may not have classic systemic signs of infection such as fever and leukocytosis on initial presentation [14]. In these patients, hyperglycemia may be a more sensitive measure of infection.

WOUND DEBRIDEMENT

Wounds that have devitalized tissue, contamination, or residual suture material benefit from debridement prior to further wound management. Wound base preparation facilitates ordered restoration and regeneration of damaged tissue and may enhance the function of specialized wound care products and advanced biologic tissue substitutes [15,16].

- Acute traumatic wounds may have irregular devitalized edges or foreign material within the wound, and surgical wounds that have dehisced may have an infected exudate, bowel contamination, necrotic muscle, or fascia. These materials impede the body's attempt to heal by stimulating the production of abnormal metalloproteases and consuming the local biologic resources necessary for healing.

- Characteristics of chronic wounds that prevent an adequate cellular response to wound-healing stimuli include accumulation of devitalized tissue, decreased angiogenesis, hyperkeratotic tissue, exudate, and biofilm formation (ie, bacterial overgrowth on the surface of the wound) [17]. The majority of wounds often require planned serial debridement to restore an optimal wound healing environment [18]. For those minority of patients where serial debridement may not be tolerated, enzymatic or biologic (larval) debridement might be helpful to potentially increase "antibiotic-free days" while reducing treatment complexity [19-22]. These interventions may also be of benefit in the time interval between serial debridements.

Bleeding from the surface of the wound commonly occurs during debridement. The propensity for a wound to bleed depends upon the type of wound and the stage of wound healing. Bleeding impairs the ability to see what tissue should be debrided, so if bleeding occurs after a dressing is removed, it should be stopped before commencing debridement. Bleeding can occur from the healing surfaces or from the deep layers of the skin at the wound edge. Diffuse bleeding from healing surfaces is managed with gentle pressure. Once the bleeding stops, debridement can continue. Bleeding from skin from a subdermal vessel can be coagulated (electrocautery, a silver nitrate stick) and then debridement continued.

Irrigation — Irrigation with fluid is important for decreasing the bacterial load and removing loose material and should be a part of routine wound management [1,23,24]. Low-pressure irrigation (eg, <15 pounds per square inch [psi]) can be performed in any setting using a syringe or bulb, whereas high-pressure irrigation (eg, pulsed lavage) is typically performed in the operative setting using a commercial device.

Low-pressure irrigation is usually adequate to remove material from the surface of most wounds. However, decreased bacterial load has been documented with the use of pulsed irrigation in lower extremity chronic wounds [25]. Bacteria do not appear to accompany the

irrigation fluid into adjacent tissues in animal studies, even at higher pressure levels [26]. In an experimental model, high-pressure irrigation decreased bacterial levels more than bulb irrigation (average reduction, 70 versus 44 percent) with no increase in the rate of bacteremia [27]. For highly contaminated wounds, the benefits of reducing bacterial load may outweigh the risk of speculative adjacent tissue damage associated with the use of higher irrigating pressures. Although higher-pressure irrigators may lead to relatively minor local tissue damage and increased tissue edema, there are no specific data available to suggest a specific cutoff pressure above which tissue damage or impaired, rather than improved, wound healing will occur.

There is no high-level evidence to support the use of any particular additive to the irrigant, nor any particular additive over another. The act of irrigation and the volume of irrigant probably provides the primary positive benefits. Warm, isotonic (normal) saline is typically used; however, systematic reviews have found no significant differences in rates of infection for tap water compared with saline for wound cleansing [28,29]. The addition of dilute iodine or other antiseptic solutions (eg, chlorhexidine, hydrogen peroxide, sodium hypochlorite) is generally unnecessary. Such additives have minimal action against bacteria, and some, but not all, may impede wound healing [30-32]. (See 'Antiseptics and antimicrobial agents' below.)

Surgical — Sharp excisional debridement uses a scalpel or other sharp instruments (eg, scissors or curette) to remove devitalized tissue and accumulated debris (biofilm). Sharp excisional debridement of chronic wounds decreases bacterial load and stimulates contraction and wound epithelialization [33]. Surgical debridement is the most appropriate choice for removing large areas of necrotic tissue and is indicated whenever there is any evidence of infection (cellulitis, sepsis). Surgical debridement is also indicated in the management of chronic nonhealing wounds to remove infected tissue, handle undermined wound edges, or obtain deep tissue for culture and pathology [18,34,35]. Serial surgical debridement in a clinical setting, when appropriate, appears to be associated with an increased likelihood of healing [18,36].

In patients with active infection, antibiotic therapy should be targeted and determined by wound culture and sensitivity to decrease the development of bacterial resistance [37,38]. (See "Acute cellulitis and erysipelas in adults: Treatment".)

In patients with chronic critical limb ischemia, surgical debridement should be coupled with revascularization in order to be successful [39]. (See "Management of chronic limb-threatening ischemia".)

Enzymatic — Enzymatic debridement involves applying exogenous enzymatic agents to the wound. Many products are commercially available (table 1), but results of clinical studies are mixed and their specific effect remains unclear [40]. Ulcer healing rates are not improved with the use of most topical agents, including debriding enzymes [41]. However, collagenase may promote endothelial cell and keratinocyte migration, thereby stimulating angiogenesis and epithelialization as its mechanism of action, rather than functioning as a strict debridement agent [42]. It also remains a good option in patients who require debridement but are not surgical candidates.

Biologic — An additional method of wound debridement uses the larvae of the Australian sheep blow fly (*Lucilia [Phaenicia] cuprina*) or green bottle fly (*Lucilia [Phaenicia] sericata*, Medical Maggots) [43,44]. Maggot therapy can be used as a bridge between debridement procedures, or for debridement of chronic wounds when surgical debridement is not available or cannot be performed [45]. Maggot therapy may also reduce the duration of antibiotic therapy in some patients [19].

Maggot therapy has been used in the treatment of pressure ulcers [46,47], chronic venous ulceration [48-51], diabetic ulcers [43,52], and other acute and chronic wounds [53]. The larvae secrete proteolytic enzymes that liquefy necrotic tissue, which is subsequently ingested while leaving healthy tissue intact. Basic and clinical research suggests that maggot therapy has additional benefits, including antimicrobial action and stimulation of wound healing [44,48,54,55]. However, randomized trials have not found consistent reductions in the time to wound healing compared with standard wound therapy (eg, debridement, hydrogel, moist dressings) [56,57]. Maggot therapy appears to be at least equivalent to hydrogel in terms of cost [57,58].

Dressing changes include the application of a perimeter dressing and a cover dressing of mesh (chiffon) that helps direct the larvae into the wound and limits their migration (movie 1). Larvae are generally changed every 48 to 72 hours. One study that evaluated maggot therapy in chronic venous wounds found no advantage to continuing maggot therapy beyond one week [49]. Patients were randomly assigned to maggot therapy (n = 58) or conventional treatment (n = 61). The difference in the slough percentage was significantly increased in the maggot therapy group compared with the control groups at day 8 (67 versus 55 percent), but not at 15 or 30 days.

The larvae can also be applied within a prefabricated "biobag" (picture 1), commercially available outside the United States, that facilitates application and dressing change [59-62]. Randomized trials comparing "free range" with "biobag"-contained larvae in the debridement of wounds have not been performed.

A main disadvantage of maggot therapy relates to negative perceptions about its use by patients and staff. One concern among patients is the possibility that the larvae can escape the dressing, although this rarely occurs. Although one study identified that approximately 50 percent of patients indicated they would prefer conventional wound therapy over maggot therapy, 89 percent of the patients randomly assigned to maggot therapy said they would undergo larval treatment again [63]. Perceived pain or discomfort with the dressings associated with maggot therapy may limit its use in approximately 20 percent of patients [64].

WOUND PACKING

Wounds with large soft-tissue defects may have an area of dead space between the surface of intact healthy skin and the wound base. These wounds are described as tunneled or undermined. Undermining is defined as extension of the wound under intact skin edges such that the wound measures larger at its base than is appreciated at the skin surface. When describing and documenting undermined wounds on the plantar aspect of the foot, it can be helpful to use a clock face analogy to illustrate the direction and location of undermining. Twelve o'clock (or the top of a clock) is distally in the direction of the toes, 6 o'clock (or the bottom of a clock) is proximally in the direction of the heel, 3 o'clock is medial, and 9 o'clock is lateral. The presence of necrotic tissue indicates the need for surgical debridement to decrease bacterial burden and prevent sequelae of infection [37].

Although there have been no specific trials comparing packed versus unpacked wounds, wound packing is considered basic standard care [65]. Packing wounds associated with significant dead space or undermining is important to reduce physiological dead space, absorb exudate/seroma collection, and reduce the potential for infection. Packing can also be an effective temporary dressing technique between planned serial debridements.

A traditional gauze dressing is often used to pack wounds to aid in continuing debridement of devitalized tissue from the wound bed. The gauze is moistened with normal saline or tap water and placed into the wound and covered with dry layers of gauze. As the moistened gauze dries, it adheres to surface tissues, which are then removed when the dressing is changed. Dressing changes should be frequent enough that the gauze does not dry out completely, which can be two to three times daily. A disadvantage of gauze dressings is that they can also remove developing granulation tissue, resulting in reinjury. Thus, these dressings are discontinued when all the necrotic tissue has been removed and granulation is occurring. An alternative to gauze dressing for managing wounds with significant dead space is negative pressure wound therapy. (See 'Negative pressure wound therapy' below.)

Many of the materials that are used as topical dressings for wounds (foams, alginates, hydrogels) can be molded into the shape of the wound and are useful for wound packing. As with their use in dressing wounds, there is little consensus over what constitutes the best material for wound packing. (See 'Wound dressings' below.)

Wound dressing changes associated with large defects can be managed without repeated applications of tape to the skin by using Montgomery straps (picture 2).

TOPICAL THERAPY

After appropriately addressing debridement of necrotic tissue, pressure offloading, infection, and ischemia, there are a number of adjunctive therapies that may be helpful to augment wound healing.

Growth factors — Growth factors important for wound healing include platelet-derived growth factor (PDGF), fibroblast growth factor (FGF), and granulocyte-macrophage colony stimulating factor (GM-CSF), amongst others. (See "Basic principles of wound healing".)

Recombinant human growth factors have been developed and are being actively investigated for the treatment of chronic ulcers, mostly those affecting the lower extremity. As with other therapies, isolated growth factors applied in the absence of good-quality debridement, infection control, and offloading when indicated are likely to be ineffective in promoting healing [34,66].

- Platelet-derived growth factor – Becaplermin is a PDGF gel preparation that promotes cellular proliferation and angiogenesis and thereby improves wound healing [67]. It is approved for use in the United States as an adjuvant therapy for the treatment of diabetic foot ulcers and is the only pharmacological agent approved for the treatment of chronic wounds. The growth factor is delivered in a topical aqueous-based sodium carboxymethylcellulose gel. It is indicated for noninfected diabetic foot ulcers that extend into the subcutaneous tissue and have an adequate vascular supply [68]. A black box warning mentions a concern for malignancy; however, the overall malignancy risk is believed to be low. Malignancy complications of this therapy may reflect usage of the agent in multiple courses of treatment, and possible selective transformation of wounds already at risk [69]. A post-marketing study found an increased rate of mortality secondary to malignancy in patients treated with three or more tubes of becaplermin (3.9 versus 0.9 per 1000 person years) compared with controls [70,71]. (See "Management of diabetic foot ulcers", section on 'Growth factors'.)

- Epidermal growth factor – In a study of chronic venous ulcers, topical application of human recombinant epidermal growth factor was associated with a greater reduction in ulcer size (7 versus 3 percent reduction) and higher ulcer healing rate (35 versus 11 percent) compared with placebo, but these differences were not statistically significant [72]. Epithelialization was not significantly affected.

- Granulocyte-macrophage colony stimulating factor – Intradermal injections of GM-CSF promote healing of chronic leg ulcers, including venous ulcers [73,74]. A trial that randomly assigned 60 patients with venous ulcers to four weekly injections with GM-CSF 200 mcg, 400 mcg, or placebo found significantly higher rates of healing at 13 weeks in the GM-CSF group (57, 61, and 19 percent, respectively) [74]. GM-CSF has been used in various types of chronic wounds to promote healing [75]. (See "Evaluation and management of chronic venous insufficiency including venous leg ulcer", section on 'Ulcer care'.)

Antiseptics and antimicrobial agents — Some topical antimicrobials may be associated with potential benefits in selected patient populations. The properties of some broadly used agents are reviewed briefly below; others are reviewed separately (table 2). (See "Topical agents and dressings for local burn wound care".)

Iodine-based — Cadexomer iodine (eg, Iodosorb) is an antimicrobial that reduces bacterial load within the wound and stimulates healing by providing a moist wound environment [76]. Cadexomer iodine is bacteriocidal to all gram-positive and gram-negative bacteria. For topical preparations, there is some evidence to suggest that cadexomer iodine generates higher healing rates than standard care but should likely only be considered for use on a short-term basis.

Silver-based — Although silver is toxic to bacteria, silver-containing dressings have not demonstrated significant benefits in comparison with other topical wound dressings [77-79]. A systematic review evaluating topical silver in infected wounds identified three trials that treated 847 participants with various silver-containing dressings [80]. One trial compared silver-containing foam (Contreet) with hydrocellular foam (Allevyn) in patients with leg ulcers. The second compared a silver-containing alginate (Silvercel) with an alginate alone (Algosteril). The third trial compared a silver-containing foam dressing (Contreet) with best local practice in patients with chronic wounds. Silver-containing foam dressings were not found to significantly improve ulcer healing at four weeks compared with non-silver-containing dressings for best local practices. Nevertheless, silver dressings are used by many clinicians to decrease the heavy bacterial surface contamination [81].

Honey — Honey has been used since ancient times for the management of wounds. Honey has broad-spectrum antimicrobial activity due to its high osmolarity and high concentration of hydrogen peroxide [82]. Medical-grade honey products are now available as a gel, paste, and impregnated into adhesive, alginate, and colloid dressings [83,84]. Based upon the results of systematic reviews evaluating honey to aid healing in a variety of wounds, there are insufficient data to provide any recommendations for the routine use of honey for all wound types; specific wound types, such as burns, may benefit, whereas others, such as chronic venous ulcers, may not [85-94].

Beta blockers — Keratinocytes have beta-adrenergic receptors, and beta blockers may influence their activity and increase the rate of maturation and migration. The use of systemic beta blockers has been studied in burn patients [95], and several case studies have presented the use of topical timolol in chronic wounds [96-98].

Timolol is a topically applied beta blocker with some limited evidence that it promotes keratinocyte migration and epithelialization of chronic wounds, which have been unresponsive to standard wound interventions.

WOUND DRESSINGS

When a suitable dressing is applied to a wound and changed appropriately, the dressing can arguably have a significant impact on the speed of wound healing, wound strength and function of the repaired skin, and cosmetic appearance of the resulting scar. No single dressing is perfect for all wounds; rather, a clinician should evaluate individual wounds and choose the best dressing on a case-by-case basis. Examples of differing types of wounds and potential dressings are given in the tables (table 3 and table 4). In addition, wounds must be continually monitored as their characteristics and dressing requirements change over time [99].

There is little clinical evidence to aid in the choice between the different types of wound dressings. Consensus opinion supports the following general principles for chronic wound management [100], but similar principles may be used for acute wound management:

- Hydrogels for the debridement stage
- Low-adherent dressings that maintain moisture balance for the granulation stage
- Low-adherent dressings for the epithelialization stage

For acute and chronic wound dressing selection, the degree of drainage/moisture should help guide the clinician in terms of dressing selection. A relatively moist wound bed is clearly beneficial for healing, while excessive moisture is detrimental, leading to maceration. The ideal

dressing for a given wound would wick away excess drainage while maintaining an appropriate level of moisture. Although some dressings may have additional benefits in terms of local antimicrobial effects, reduced pain on change, odor control, and anti-inflammatory or mild debridement ability, these are secondary benefits [101].

Dressings are typically changed once a day or every other day to avoid disturbing the wound healing environment. Because some dressings may impede some aspects of wound healing, they should be used with caution. As examples, alginate dressings with high calcium content may impede epithelialization by triggering premature terminal differentiation of keratinocytes [100], and highly silver-containing dressings are potentially cytotoxic and should not be used in the absence of significant infection. (See 'Antiseptics and antimicrobial agents' above and 'Alginates' below.)

The advantages and disadvantages of the various dressing types are discussed below. (See 'Common dressings' below.)

Importance of moisture — For much of the history of medicine, it was believed that wounds should not be occluded but left exposed to the air. However, an important study in a pig model showed that moist wounds healed more rapidly compared with wounds that dried out [102]. Similar results have been obtained in humans [103-105].

Occluded wounds heal up to 40 percent more rapidly than nonoccluded wounds [103]. This is thought to be due, in part, to easier migration of epidermal cells in the moist environment created by the dressing [104]. Another mechanism for improved wound healing may be the exposure of the wound to its own fluid [106]. Acute wound fluid is rich in platelet-derived growth factor, basic fibroblast growth factor, and has a balance of metalloproteases serving a matrix custodial function [107]. These interact with one another and with other cytokines to stimulate healing [108]. On the other hand, the effect of chronic wound fluid on healing may not be beneficial. Chronic wound fluid is very different from acute wound fluid and contains persistently elevated levels of inflammatory cytokines that may inhibit proliferation of fibroblasts [109-111]. Excessive periwound edema and induration contributes to the development of chronic wound fluid and should be managed to minimize this effect. (See "Basic principles of wound healing", section on 'Wound healing'.)

In addition to faster wound healing, wounds treated with occlusive dressings are associated with less prominent scar formation [112]. One study of porcine skin found an acceleration in the inflammatory and proliferative phases of healing when wounds were covered with an occlusive dressing as opposed to dry gauze [113]. This "acceleration" through the wound phases may prevent the development of a chronic wound state, which is typically arrested in the

inflammatory phase of healing. Wounds that have a greater amount of inflammation tend to result in more significant scars, and thus the decreased inflammation and proliferation seen with wound occlusion may also decrease the appearance of the scar.

An ideal dressing is one that has the following characteristics (table 3):

- Absorbs excessive wound fluid while maintaining a moist environment
- Protects the wound from further mechanical or caustic damage
- Prevents bacterial invasion or proliferation
- Conforms to the wound shape and eliminates dead space
- Debrides necrotic tissue
- Does not macerate the surrounding viable tissue
- Achieves hemostasis and minimizes edema through compression
- Does not shed fibers or compounds that could cause a foreign body or hypersensitivity reaction
- Eliminates pain during and between dressing changes
- Minimizes dressing changes
- Is inexpensive, readily available, and has a long shelf life
- Is transparent in order to monitor wound appearance without disrupting dressing

In most cases, a dressing with all of these characteristics is not available, and a clinician must decide which of these is most important in the case of a particular wound. The moisture content of a wound bed must be kept in balance for both acute and chronic wounds. The area should be moist enough to promote healing, but excess exudate must be absorbed away from the wound to prevent maceration of the healthy tissue.

Common dressings — Although dressings can be categorized based upon many characteristics (table 3), it is most useful to classify dressings by their water-retaining abilities because the primary goal of a dressing is the maintenance of moisture in the wound environment. As such, dressings are classified as open, semi-open, or semi-occlusive.

Open dressings include, primarily, gauze, which is typically moistened with saline before placing it into the wound. Gauze bandages are available in multiple sizes, including 2 x 2 inch and 4 x 4 inch square dressings and in 3 or 4 inch rolls. Thicker absorbent pads are used to cover the gauze dressings. For managing large wounds, self-adhesive straps can be used to hold a bulky dressing in place. As discussed above, dried gauze dressings are discouraged. Wet-to-moist gauze dressings are useful for packing large soft-tissue defects until wound closure or coverage can be performed. Gauze dressings are inexpensive but often require frequent dressing changes.

Semi-open dressings typically consist of fine mesh gauze impregnated with petroleum, paraffin wax, or other ointment, and have product names such as Xeroform, Adaptic, Jelonet, and Sofra Tulle. This initial layer is covered by a secondary dressing of absorbent gauze and padding, then finally a third layer of tape or other method of adhesive. Benefits of semi-open dressings include their minimum expense and their ease of application. The main disadvantage of this type of dressing is that it does not maintain a moisture-rich environment or provide good exudate control. Fluid is permitted to seep through the first layer and is collected in the second layer, allowing for both desiccation of the wound bed and maceration of the surrounding tissue in contact with the secondary layer. Other disadvantages include the bulk of the dressing, its awkwardness when applied to certain areas, and the need for frequent changing.

Semi-occlusive dressings come in a wide variety of occlusive properties, absorptive capacities, conformability, and bacteriostatic activity. Semi-occlusive dressings include films, foams, alginates, hydrocolloids, and hydrogels, and are discussed below.

Films — Polymer films are transparent sheets of synthetic self-adhesive dressing that are permeable to gases such as water vapor and oxygen but impermeable to larger molecules, including proteins and bacteria. This property enables insensible water loss to evaporate, traps wound fluid enzymes within the dressing, and prevents bacterial invasion. These dressings are sometimes known as synthetic adhesive moisture-vapor-permeable dressings, and include Tegaderm, Cutifilm, Blisterfilm, and Bioclusive. Transparent film dressings were found to provide the fastest healing rates, lowest infection rates, and to be the most cost-effective method for dressing split-thickness skin graft donor sites in a review of 33 published studies [114].

Advantages of these dressings include their ability to maintain moisture, encourage rapid reepithelization, and their transparency and self-adhesive properties. Disadvantages of film dressings include limited absorptive capacity, and they are not appropriate for moderately to heavily exudative wounds. If they are allowed to remain in place over a wound with heavy exudates, the surrounding skin is likely to become macerated. In addition, if the wound dries out, film dressings may adhere to the wound and be painful and damaging to remove.

Foams — Foam dressings can be thought of as film dressings with the addition of absorbency. They consist of two layers, a hydrophilic silicone or polyurethane-based foam that lies against the wound surface, and a hydrophobic, gas-permeable backing to prevent leakage and bacterial contamination. Some foams require a secondary adhesive dressing. Foams are marketed under names such as Allevyn, Adhesive, Lyofoam, and Spyrosorb.

Advantages of foams include their high absorptive capacity and the fact that they conform to the shape of the wound and can be used to pack cavities. Disadvantages of foams include the opacity of the dressings and the fact that they may need to be changed each day. Foam dressings may not be appropriate on minimally exudative wounds, as they may cause desiccation.

One small trial compared foams to films as dressings for skin tears in institutionalized adults and found that more complete healing occurred in the group using foams [115].

Alginates — Natural complex polysaccharides from various types of algae form the basis of alginate dressings. Their activity as dressings is unique because they are insoluble in water, but in the sodium-rich wound fluid environment these complexes exchange calcium ions for sodium ions and form an amorphous gel that packs and covers the wound. Alginates come in various forms including ribbons, beads, and pads. Their absorptive capacity ranges depending upon the type of polysaccharide used. In general, these dressings are more appropriate for moderately to heavily exudative wounds.

Advantages of alginates include augmentation of hemostasis [116,117], they can be used for wound packing, most can be washed away with normal saline in order to minimize pain during dressing changes, and they can stay in place for several days. Disadvantages of alginates are that they require a secondary dressing that must be removed in order to monitor the wound, they can be too drying on a minimally exudative wound, and they have an unpleasant odor.

In a trial of 77 patients, patients with diabetic foot wounds were randomly assigned to alginate or petroleum gauze dressings [118]. Patients treated with alginates were found to have significantly superior granulation tissue coverage at four weeks of treatment, significantly less pain, and fewer dressing changes than the petroleum gauze group.

Hydrocolloids — Hydrocolloid dressings usually consist of a gel or foam on a carrier of self-adhesive polyurethane film. The colloid composition of this dressing traps exudate and creates a moist environment. Bacteria and debris are also trapped and washed away with dressing changes in a gentle, painless form of mechanical debridement. Another advantage of hydrocolloids is the ability to use them for packing wounds. Disadvantages include malodor and the potential need for daily dressing changes, and allergic contact dermatitis has been reported [119]. Hydrocolloid products include DuoDERM, Tegasorb, J and J Ulcer Dressing, and Comfeel.

Cadexomer iodine is a type of hydrocolloid in which iodine is dispersed and slowly released after it comes in contact with wound fluid. The concentration of iodine released is low and does not cause tissue damage [120]. A multicenter trial found that over a 12-week period, cadexomer iodine paste was more cost-effective than non-iodinated hydrocolloid dressing or paraffin

gauze dressing in patients with exudating venous ulcers [121]. A systematic review found some evidence that topical application of cadexomer iodine enhanced venous ulcer healing rates compared with standard care (with and without compression) [41]. The treatment regimen was complex, and it is unclear if the results are generalizable to most clinical settings. Iodine-induced hyperthyroidism has been documented with use of cadexomer iodine for leg ulcers [122]. (See 'Antiseptics and antimicrobial agents' above.)

Hydrogels — Hydrogels are a matrix of various types of synthetic polymers with >95 percent water formed into sheets, gels, or foams that are usually sandwiched between two sheets of removable film. The inner layer is placed against the wound, and the outer layer can be removed to make the dressing permeable to fluid. Sometimes a secondary adhesive dressing is needed. These unique matrices can absorb or donate water depending upon the hydration state of the tissue that surrounds them. Hydrogel products include Intrasite Gel, Vigilon, Carrington Gel, and Elastogel.

Hydrogels are most useful for dry wounds. They initially lower the temperature of the wound environment they cover, which provides cooling pain relief for some patients [123]. As a disadvantage, although there have been no reports of increased wound infection, hydrogels have been found to selectively permit gram-negative bacteria to proliferate [124].

Hydroactive — Hydroactive, the most recently developed synthetic dressing, is a polyurethane matrix that combines the properties of a gel and a foam. Hydroactive selectively absorbs excess water while leaving growth factors and other proteins behind [125].

A randomized trial compared hydroactive dressings with two different hydrocolloids and found the hydroactive dressing to be equally effective at promoting ulcer healing and alleviating ulcer-associated pain after 12 weeks of treatment [126]. Another study found hydroactive dressings combined with enzymatic debridement to be more cost-efficient than gauze alone in dressing pressure ulcers and venous stasis ulcers [127].

WOUND CLOSURE

Primary closure refers to the direct apposition of skin edges of acute surgical or traumatic wounds after appropriate wound preparation with sutures and/or staples (figure 1 and figure 2). (See "Minor wound evaluation and preparation for closure" and "Skin laceration repair with sutures" and "Closure of minor skin wounds with staples".)

This might be contrasted with delayed primary closure, where skin edge apposition occurs following an interval of wound management. In other words, the wound is purposefully left

open for a period of time, and then the edges are directly apposed with sutures and/or staples. Although delayed, this still represents primary closure as the skin edges are brought into direct apposition by external means. For abdominal wounds, chest wounds, and surgical wounds without evidence of infection, delayed closure is widely accepted (figure 1) [128]. However, while a chronic wound should never be closed primarily, delayed closure or coverage of chronic wounds is acceptable.

Another option still is healing by secondary intention (figure 1). This is where a wound is purposefully left open and fills in with granulation tissue and eventually epithelization over a period of time. At no point are the skin edges brought together by external means. The process of healing by secondary intention might be assisted by the use of negative pressure wound therapy.

Negative pressure wound therapy — Negative pressure wound therapy enhances wound healing by reducing edema surrounding the wound, stimulating circulation, and increasing the rate of granulation tissue formation [129-132]. The technique involves the application of a controlled subatmospheric pressure to a wound covered with a foam dressing. Negative pressure wound therapy is useful to manage large defects until closure can be performed. It has also been used with modest success in the treatment of pressure ulcers [133-135] and diabetic wounds [132,136]. (See "Negative pressure wound therapy".)

WOUND COVERAGE

Split-thickness and full-thickness skin grafts are the most basic biologic dressings and consist of skin taken from a donor site and grafted onto a wound on the same patient. Skin grafts are used to prevent fluid and electrolyte loss and reduce bacterial burden and infection. Skin transplanted from one location to another on the same individual is termed an autogenous graft or autograft. Skin grafts are classified as either split-thickness or full-thickness, depending upon the amount of dermis included in the graft. A partial or split-thickness skin graft contains a variable thickness of dermis, while a full-thickness skin graft contains the entire dermis. With full-thickness grafts, the characteristics of normal skin are maintained with a thicker dermal component. However, thicker grafts require a more robust wound bed due to the greater amount of tissue that needs to be revascularized. The choice between full- and split-thickness skin grafting depends upon the condition of the wound, location, size, and need for cosmesis [137,138]. (See "Skin autografting", section on 'Split-thickness skin grafting' and "Skin autografting", section on 'Full-thickness skin grafting'.)

Biologic cell-based dressings are composed of a live-cell construct that contains at least one layer of live allogenic cells. Skin substitutes can be used when traditional dressings have failed or are deemed inappropriate [139]. One study suggested their use when a chronic wound fails to heal at an appropriate rate of closure (ie, 55 percent reduction in wound area within four weeks of treatment) [140]. Skin substitutes are ideal for the treatment of chronic ulcers because additional cells and growth factors are added to a deficient wound-healing environment. Accelerated wound healing reduces the risk of wound infection. (See "Skin substitutes".)

For larger wounds or loss of multiple tissue components (skin, subcutaneous tissue, muscle), a tissue flap may be required to provide adequate wound coverage. (See "Overview of flaps for soft tissue reconstruction".)

ADJUNCTIVE THERAPIES

Hyperbaric oxygen therapy — Hyperbaric oxygen therapy (HBOT) has been demonstrated to have positive effects on wound healing in vitro in many situations [141]. Endothelial progenitor cells play an important role in wound healing because they participate in the formation of new blood vessels in areas of hypoxia [142]. Although hyperoxia induced by HBOT effectively improves endothelial progenitor cells' mobilization, therapy is not targeted to the wound site. (See "Hyperbaric oxygen therapy", section on 'Mechanisms of action'.)

Although HBOT has been used as an adjunct to wound care in the treatment of a variety of acute and chronic wounds [143-148], the specific indications are relatively unclear. Most studies are observational, and the few available trials are limited by small sample size and low quality [149-151]. Systematic reviews have concluded that, although hyperbaric oxygen may benefit some types of wounds (eg, diabetic ulcers), there is insufficient evidence to support routine use [152-154]. It is reasonable to conclude that HBOT might be considered in situations of chronic wounds that have not responded to conventional interventions, in relatively ischemic states where revascularization is not an option, and in the setting of subacute osteonecrosis not amenable to surgical excision. (See "Overview of treatment of chronic wounds", section on 'Hyperbaric oxygen therapy/topical oxygen therapy'.)

- HBOT may be of value in patients with extensive soft tissue injury. A systematic review identified three trials evaluating the use of HBOT in acute surgical and traumatic wounds [155]. In one of the trials, 36 patients with crush injuries were randomly assigned to a 90 minute twice daily HBOT or sham treatments for a total of six days postoperatively [156]. The group treated with hyperbaric oxygen had significantly more complete healing (17 versus 10 patients) and required fewer skin flaps, grafts, vascular surgery, or amputation

(1 versus 6 patients). (See "Surgical management of severe lower extremity injury", section on 'Wound care and coverage' and "Patient management following extremity fasciotomy", section on 'Hyperbaric oxygen'.)

- A systematic review of HBOT in burn wounds found only two high-quality trials and concluded that there was insufficient evidence to support the use of HBO following thermal injury [157]. The treatment of burn wounds is discussed in detail elsewhere. (See "Topical agents and dressings for local burn wound care".)

- HBOT may improve the survival of skin grafts and reconstructive flaps that have compromised blood flow, thereby preventing tissue breakdown and the development of wounds. Patients who require skin grafting or reconstructive flaps in areas with local vascular compromise, previous radiation therapy, or in sites of previous graft failure may benefit from prophylactic therapy. (See "Hyperbaric oxygen therapy", section on 'Radiation injury'.)

When indicated, HBOT is accomplished in a specialized chamber that allows for patient monitoring. Chamber pressure is typically maintained between 2.5 and 3.0 atmospheres of pressured oxygen or air. Therapy for nonhealing wounds generally consists of daily sessions of 1.5 to 2 hours for 20 to 40 days [141]. The mechanisms and technique of HBOT are discussed in detail elsewhere. Serious adverse events can be associated with HBOT, including seizures and pneumothorax. (See "Hyperbaric oxygen therapy" and "Hyperbaric oxygen therapy", section on 'Technique'.)

Topical oxygen therapy — While HBOT has a systemic mechanism of action through increased binding of oxygen to red blood cells, which potentially leads to increased peripheral cellular diffusion, increased levels of oxygen might also be delivered locally with topical oxygen therapy, albeit likely without the direct cellular effects [158-161]. The local hyperoxic state more likely generally affects the wound bed environment and might have some bactericidal properties. Like most topical interventions, the direct effects of topical oxygen therapy on wound healing are difficult to specifically elucidate, but it represents an option with some marginal potential benefits and relatively minimal complications.

Other therapies — A variety of other therapies, such as low-frequency ultrasound [162,163], electrical stimulation [164-167], electromagnetic therapy [168], and phototherapy [169], have been investigated primarily for the treatment of pressure ulcers or chronic venous wounds [170-174]. The treatment of pressure ulcers and chronic venous wounds are discussed in detail elsewhere. (See "Clinical staging and general management of pressure-induced skin and soft

tissue injury" and "Evaluation and management of chronic venous insufficiency including venous leg ulcer", section on 'Ulcer care'.)

MANAGEMENT OF SPECIFIC WOUNDS

Acute wounds

- **Simple laceration** – Simple traumatic lacerations may be cleaned and closed primarily with either staples or sutures. (See "Minor wound evaluation and preparation for closure" and "Skin laceration repair with sutures" and "Closure of minor skin wounds with staples".)

- **Complicated laceration** – Following cleansing of the wound and debridement, an attempt is often made to close more complicated lacerations (eg, stellate, contiguous, intersecting). It is not uncommon for the irregular skin edges or skin at sites where lacerations meet to break down. Plastic surgery techniques may be needed to provide an acceptable cosmetic and functional result. (See "Z-plasty".)

- **Large tissue defect** – Large tissue defects can result from traumatic wounds or the need to remove devitalized tissue due to infection (eg, Fournier's gangrene). Once the debridement is completed, the wound can be packed open with wet-to-moist saline gauze dressings or using negative pressure wound therapy until the wound bed allows for skin graft or flap closure [132]. (See 'Wound packing' above and 'Negative pressure wound therapy' above.)

- **Burns** – Burn wound care depends upon many factors, including the depth of the burn and anatomic locations. (See "Emergency care of moderate and severe thermal burns in adults", section on 'Wound management' and "Overview of surgical procedures used in the management of burn injuries".)

- **Postoperative surgical incision** – Postoperative surgical incisions (clean, clean-contaminated) are typically covered with a dry dressing that is held in place with an adhesive (eg, tape, Tegaderm). The initial postoperative dressing can be removed within 48 hours, provided the wound has remained dry. The timing with which the patient can resume bathing/showering is not well defined [175,176].

Chronic wounds — The management of chronic wounds (eg, pressure ulcers, diabetic foot ulcers, ischemic ulcerations and gangrene, atypical and malignancy-associated wounds) is reviewed separately. (See "Overview of treatment of chronic wounds".)

SOCIETY GUIDELINE LINKS

Links to society and government-sponsored guidelines from selected countries and regions around the world are provided separately. (See "Society guideline links: Chronic wound management".)

SUMMARY AND RECOMMENDATIONS

- **Wound bed preparation** – For optimal wound healing, the wound bed should be well vascularized, free of devitalized tissue, clear of infection, and moist. (See 'Introduction' above.)
    - **Debridement** – We suggest sharp surgical debridement over nonsurgical methods for the initial debridement of devitalized tissue associated with acute and chronic wounds or ulcers when feasible (**Grade 2C**). (See 'Wound debridement' above.)
    - **Topical therapy** – Topical agents such as antiseptics and antimicrobial agents can be used to control locally heavy contamination. Significant improvements in rates of wound healing have not been found, and toxicity to the tissues might be a significant disadvantage. (See 'Antiseptics and antimicrobial agents' above.)
- **Wound dressings and adjuncts** – Wound dressings should be chosen based upon their ability to manage dead space, control exudate, reduce pain during dressing changes (as applicable), prevent bacterial overgrowth, ensure proper fluid balance, be cost-efficient, and be manageable for the patient or nursing staff. (See 'Wound packing' above and 'Wound dressings' above.)
    - **Negative pressure wound therapy** – For deep wounds, negative pressure wound therapy may protect the wound and reduce the complexity and depth of the defect. Negative pressure wound therapy is frequently used to manage complex wounds prior to definitive closure. (See 'Negative pressure wound therapy' above.)
    - **Adjunctive therapies** – Many other therapies have been used with the aim of enhancing wound healing and include hyperbaric oxygen therapy, and wound stimulation using ultrasound, electrical, and electromagnetic energy. Some of these therapies have shown a marginal benefit in randomized studies and may be useful as adjuncts for wound healing. (See 'Adjunctive therapies' above.)

- **Wound closure** – Following wound bed preparation, acute wounds can often be closed primarily. Chronic wounds that demonstrate progressive healing as evidenced by granulation tissue and epithelialization along the wound edges can undergo delayed closure or coverage with skin grafts or bioengineered tissues. (See 'Wound closure' above and 'Wound coverage' above.)

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Topic 15912 Version 40.0

GRAPHICS

Enzymatic debriding agents

Agent	Enzyme source	Advantages	Disadvantages	Precautions
Collagenase	Strain of *Clostridium histolyticum*	▪ Approved by the US FDA for the debridement of chronic wounds and burns ▪ Selective for collagen ▪ Generally pain-free delivery ▪ May be combined with a variety of other topical dressings	▪ Effectiveness compared with other forms of debridement may be questionable ▪ Prescription based on wound area ▪ High cost ▪ Relatively slow acting	▪ Moist wound environment required for activation ▪ Topical silver dressings significantly inhibit collagenase activity
Papain	Papaya	▪ Provides relatively "aggressive" enzymatic debridement ▪ Generally pain-free delivery ▪ May be combined with a variety of other topical dressings	▪ Not readily available in the United States ▪ Nonselective (ie, will cleave any protein containing cysteine) ▪ Relatively slow acting	▪ Agent is often combined with a chlorophyll complex that causes green wound discoloration following application ▪ Need to avoid adjacent healthy tissues
Bromelain	Pineapple	▪ Relatively rapid acting ▪ Selective for nonviable tissue	▪ Removal from base of wound required after several hours ▪ Inhibits platelet function but is reversible	▪ Evidence of efficac is based on acute wounds or burns, not chronic wounds

FDA: Food and Drug Administration.

Data from:

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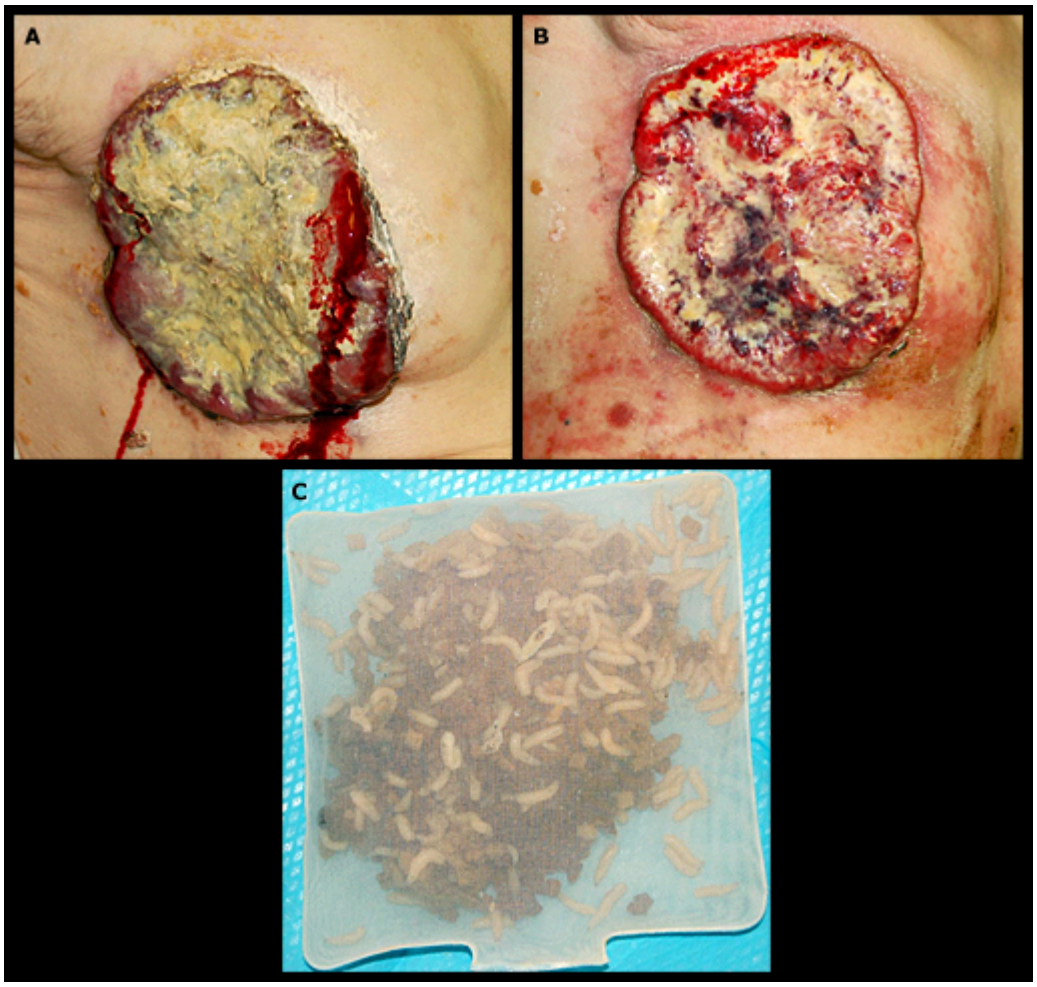
Graphic 85776 Version 5.0

Treatment of necrotic tissue with maggots



(A) Infection of necrotic skin associated with ulcerated cancer.

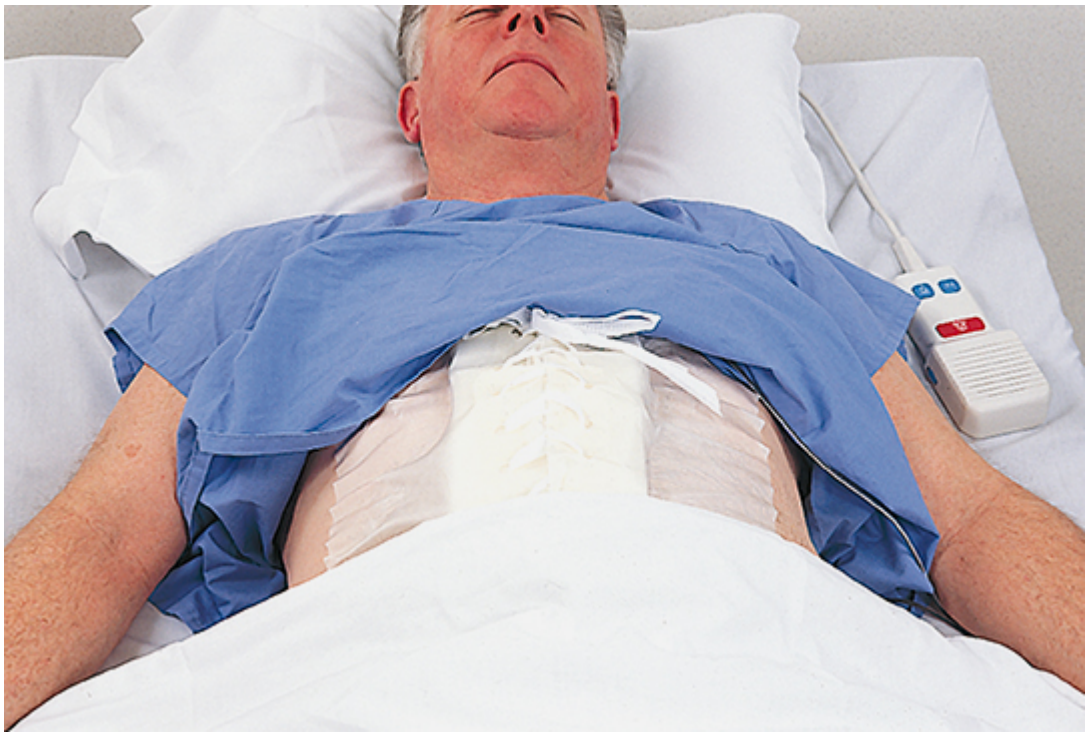
(B) After treatment with maggots.

(C) Maggots in a tea bag.

Courtesy of Michael J Dixon, MD.

Graphic 67885 Version 3.0

Montgomery straps



Montgomery straps make it possible to care for a wound without removing adhesive strips with each dressing change.

Graphic 69031 Version 1.0

Topical antimicrobial agents used for burns[1,2]

Antimicrobial agents	Clinical indications	Effectiveness	Contraindications	Adverse effects
Silver sulfadiazine (1% cream) with or without cerium	Small, medium, and large surface area burns	Decreased colonization of wounds Alleviates pain Broad spectrum No evidence to support improved wound healing or reduction in bacterial wound infections[3]	Burns near eyes Pregnancy Breastfeeding Newborns <2 months Allergic to sulfonamides Signs of reepithelialization	Skin hypersensitivity Neutropenia (usually transient) Leukopenia (usually transient) Methemoglobinemia
Silver containing dressings (eg, Acticoat, Aquacel Ag)	Small, medium, and large surface area burns	Stronger antimicrobial activity, longer duration of action than silver sulfadiazine, some evidence for reduced wound infection rates[3]	Burns near eyes Pregnancy Allergic to silver	Systemic silver uptake, temporary staining of the skin, argyrosis-argyria*[4,5
Bacitracin ointment 500 units/gram	Small surface area burns Face Ears Perineum Graft sites Alternative if allergic to sulfonamides	Ease of application and of removal Painless Frequent dressing changes	Bacterial resistance Signs of reepithelialization	Yeast colonization Skin hypersensitivity
Combination antibiotic ointment (eg, bacitracin, neomycin, and polymyxin B)	Small surface area burns Face Ears Perineum	Ease of application and of removal Painless Frequent dressing changes	Bacterial resistance Allergic reaction Signs of reepithelialization	Yeast colonization Skin hypersensitivity Ototoxicity and nephrotoxicity with neomycin-containing

	Graft sites Alternative if allergic to sulfonamides			ointments (eg, Neosporin)
Mupirocin ointment/cream 2%	Small, medium surface area burns Face Ears Nose Perineum Alternative if allergic to sulfonamides	Gram-positive coverage includes methicillin-resistant *Staphylococcus aureus* (MRSA) Ease of application and of removal Painless Frequent dressing changes	Bacterial resistance Allergic reaction Signs of reepithelialization	Yeast colonization Skin hypersensitivity
Mafenide (8.5% cream, 5% solution)	Ears Nose Dense bacterial proliferation	Excellent eschar penetration Penetrates cartilage Gram-negative coverage includes *Pseudomonas*	Burns >40% total body surface area Allergic to sulfonamides	Metabolic acidosis (inhibits carbonic anhydrase) Painful Inhibits epithelial regeneration
Chlorhexidine	Only superficial burns	Does not interfere with reepithelialization Can be used with silver sulfadiazine Generally used as a cleansing agent	Deep burns Caution in neonates – rare association with cutaneous burns	Skin hypersensitivity
Povidone-iodine	Small, medium surface area burns	Only when no other agent is available	Children under 2 years Pregnancy Breastfeeding Thyroid disorders Signs of reepithelialization	Cytotoxicity (toxic to fibroblasts, reduces cell proliferation) Painful Skin hypersensitivities Chemical burn Iodine toxicity Renal failure

				Acidosis Anaphylaxis
Acetic acid	Antiseptic, topical agent often used in a diluted form as an adjunct in the setting of *Pseudomonas aeruginosa*[6]	Gram-negative bacteria including *P. aeruginosa*[7]	Superficial burns have been described from misuse[8]	High concentrations inhibit epithelialization, inhibit PMNs and fibroblasts

Topical antimicrobial agents may increase risk of host fungal infections. Nystatin ointment or powder may be useful in combination with topical antimicrobials to decrease fungal colonization.

PMNs: polymorphonucleocytes.

* Blue-grey discoloration of tissues due to deposition of silver.

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Properties of topical agents and dressing materials

Type	Actions	Indications/use	Precautions/contraindications
Alginates/CMC*	▪ Absorb fluid. ▪ Promote autolytic debridement. ▪ Moisture control. ▪ Conformability to wound bed.	▪ Moderate to high exuding wounds. ▪ Special cavity presentations in the form of rope or ribbon. ▪ Combined presentation with silver for antimicrobial activity.	▪ Do not use on dry/necrotic wounds. ▪ Use with caution on friable tissue (may cause bleeding). ▪ Do not pack cavity wounds tightly.
Foams	▪ Absorb fluid. ▪ Moisture control. ▪ Conformability to wound bed.	▪ Moderate to high exuding wounds. ▪ Special cavity presentations in the form of strips or ribbon. ▪ Low-adherent versions available for patients with fragile skin. ▪ Combined presentation with silver or PHMB for antimicrobial activity.	▪ Do not use on dry/necrotic wounds or those with minimal exudate.
Honey	▪ Rehydrate wound bed. ▪ Promote autolytic debridement. ▪ Antimicrobial action.	▪ Sloughy, low to moderate exuding wounds. ▪ Critically colonized wounds or clinical signs of infection.	▪ May cause "drawing" pain (osmotic effect). ▪ Known sensitivity.
Hydrocolloids	▪ Absorb fluid. ▪ Promote autolytic debridement.	▪ Clean, low to moderate exuding wounds. ▪ Combined presentation with silver for	▪ Do not use on dry/necrotic wounds or high exuding wounds ▪ May encourage overgranulation. ▪ May cause maceration.

		antimicrobial activity.	
Hydrogels	▪ Rehydrate wound bed. ▪ Moisture control. ▪ Promote autolytic debridement. ▪ Cooling.	▪ Dry/low to moderate exuding wounds. ▪ Combined presentation with silver for antimicrobial activity.	▪ Do not use on highly exuding wounds or where anaerobic infection is suspected. ▪ May cause maceration.
Iodine	▪ Antimicrobial action.	▪ Critically colonized wounds or clinical signs of infection. ▪ Low to high exuding wounds.	▪ Do not use on dry necrotic tissue ▪ Known sensitivity to iodine. ▪ Short-term use recommended (risk of systemic absorption).
Low-adherent wound contact layer (silicone)	▪ Protect new tissue growth. ▪ Atraumatic to periwound skin. ▪ Conformable to body contours.	▪ Low to high exuding wounds. ▪ Use as contact layer on superficial low exuding wounds.	▪ May dry out if left in place for too long. ▪ Known sensitivity to silicone.
PHMB	▪ Antimicrobial action.	▪ Low to high exuding wounds. ▪ Critically colonized wounds or clinical signs of infection. ▪ May require secondary dressing.	▪ Do not use on dry/necrotic wounds. ▪ Known sensitivity.
Odor control (eg, activated charcoal)	▪ Odor absorption.	▪ Malodorous wounds (due to excess exudate). ▪ May require antimicrobial if due to increased bioburden.	▪ Do not use on dry wounds.
Protease modulating	▪ Active or passive control of wound protease levels.	▪ Clean wounds that are not progressing despite correction of underlying causes, exclusion of infection, and	▪ Do not use on dry wounds or those with leathery eschar.

		optimal wound care.	
Silver	▪ Antimicrobial action.	▪ Critically colonized wounds or clinical signs of infection. ▪ Low to high exuding wounds. ▪ Combined presentation with foam and alginates/CMC for increased absorbency. Also in paste form.	▪ Some may cause discoloration. ▪ Known sensitivity. ▪ Discontinue after 2 weeks if no improvement and reevaluate.
Polyurethane film	▪ Moisture control. ▪ Breathable bacterial barrier. ▪ Transparent (allow visualization of wound).	▪ Primary dressing over superficial low exuding wounds. ▪ Secondary dressing over alginate or hydrogel for rehydration of wound bed.	▪ Do not use on patients with fragile/compromised periwound skin. ▪ Do not use on moderate to high exuding wounds.

Other more advanced dressings (eg, collagen and bioengineered tissue products) may be considered for wounds that are hard to heal[1].

CMC: carboxymethylcellulose; PHMB: polyhexamethylene biguanide.

* Wound dressings may contain alginates or CMC only; alginates may also be combined with CMC.

Reference:

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Graphic 60931 Version 6.0

Wound management dressing guide

Type of tissue in the wound	Therapeutic goal	Role of dressing	Treatment options	
			Wound bed preparation	Primary dressing
▪ Necrotic, black, dry	▪ Remove devitalized tissue ▪ Do not attempt debridement if vascular insufficiency suspected ▪ Keep dry and refer for vascular assessment	▪ Hydration of wound bed ▪ Promote autolytic debridement	▪ Surgical or mechanical debridement	▪ Hydrogel ▪ Honey
▪ Sloughy, yellow, brown, black or grey ▪ Dry to low exudate	▪ Remove slough ▪ Provide clean wound bed for granulation tissue	▪ Rehydrate wound bed ▪ Control moisture balance ▪ Promote autolytic debridement	▪ Surgical or mechanical debridement if appropriate ▪ Wound cleansing (consider antiseptic wound cleansing solution)	▪ Hydrogel ▪ Honey
▪ Sloughy, yellow, brown, black or grey ▪ Moderate to high exudate	▪ Remove slough ▪ Provide clean wound bed for granulation tissue ▪ Exudate management	▪ Absorb excess fluid ▪ Protect periwound skin to prevent maceration ▪ Promote autolytic debridement	▪ Surgical or mechanical debridement if appropriate ▪ Wound cleansing (consider antiseptic wound cleansing solution)	▪ Absorbent dressing (alginate/CMC/foam) ▪ For deep wounds, use cavity strips, rope or ribbon versions

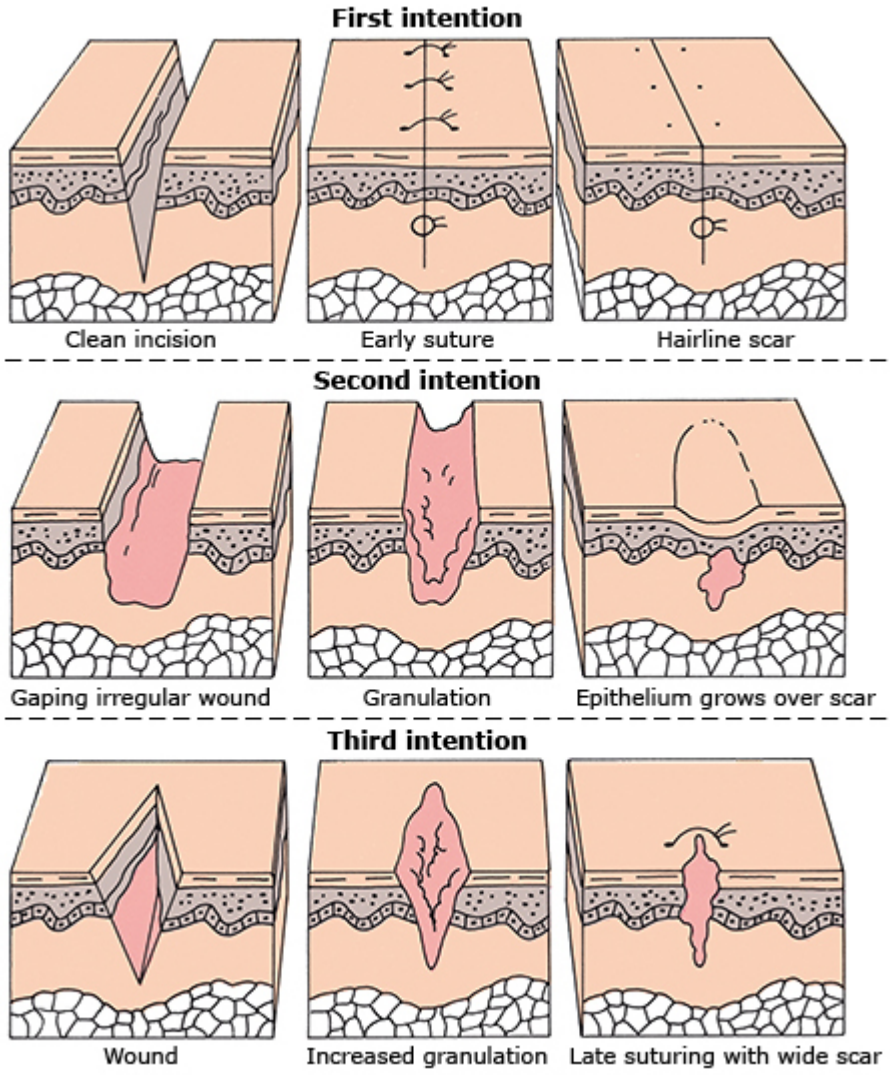
			▪ Consider barrier products	
▪ Granulating, clean, red ▪ Dry to low exudate	▪ Promote granulation ▪ Provide healthy wound bed for epithelialization	▪ Maintain moisture balance ▪ Protect new tissue growth	▪ Wound cleansing	▪ Hydrogel ▪ Low adherent (silicone) dressing ▪ For deep wounds use cavity strips, rope or ribbon versions
▪ Granulating, clean, red ▪ Moderate to high exudate	▪ Exudate management ▪ Provide healthy wound bed for epithelialization	▪ Maintain moisture balance ▪ Protect new tissue growth	▪ Wound cleansing ▪ Consider barrier products	▪ Absorbent dressing (alginate/CMC/foam) ▪ Low adherent (silicone) dressing ▪ For deep wounds, use cavity strips, rope or ribbon versions
▪ Epithelializing, red, pink ▪ No to low exudate	▪ Promote epithelialization and wound maturation (contraction)	▪ Protect new tissue growth		▪ Hydrocolloid (thin) ▪ Polyurethane film dressing ▪ Low adherent (silicone) dressing
▪ Infected ▪ Low to high exudate	▪ Reduce bacterial load ▪ Exudate management ▪ Odor control	▪ Antimicrobial action ▪ Moist wound healing ▪ Odor absorption	▪ Wound cleansing (consider antiseptic wound cleansing solution) ▪ Consider barrier products	▪ Antimicrobial dressing

The purpose of this table is to provide guidance about appropriate dressings and should be used in conjunction with clinical judgement and local protocols. Where wounds contain mixed tissue types, it is important to consider the predominant factors affecting healing and address accordingly. Where infection is suspected, it is important to regularly inspect the wound and to change the dressing frequently. Wound dressings should be used in combination with appropriate wound bed preparation, systemic antibiotic therapy, pressure offloading, and diabetic control.

CMC: carboxymethyl cellulose.

Graphic 101893 Version 2.0

Types of wound healing



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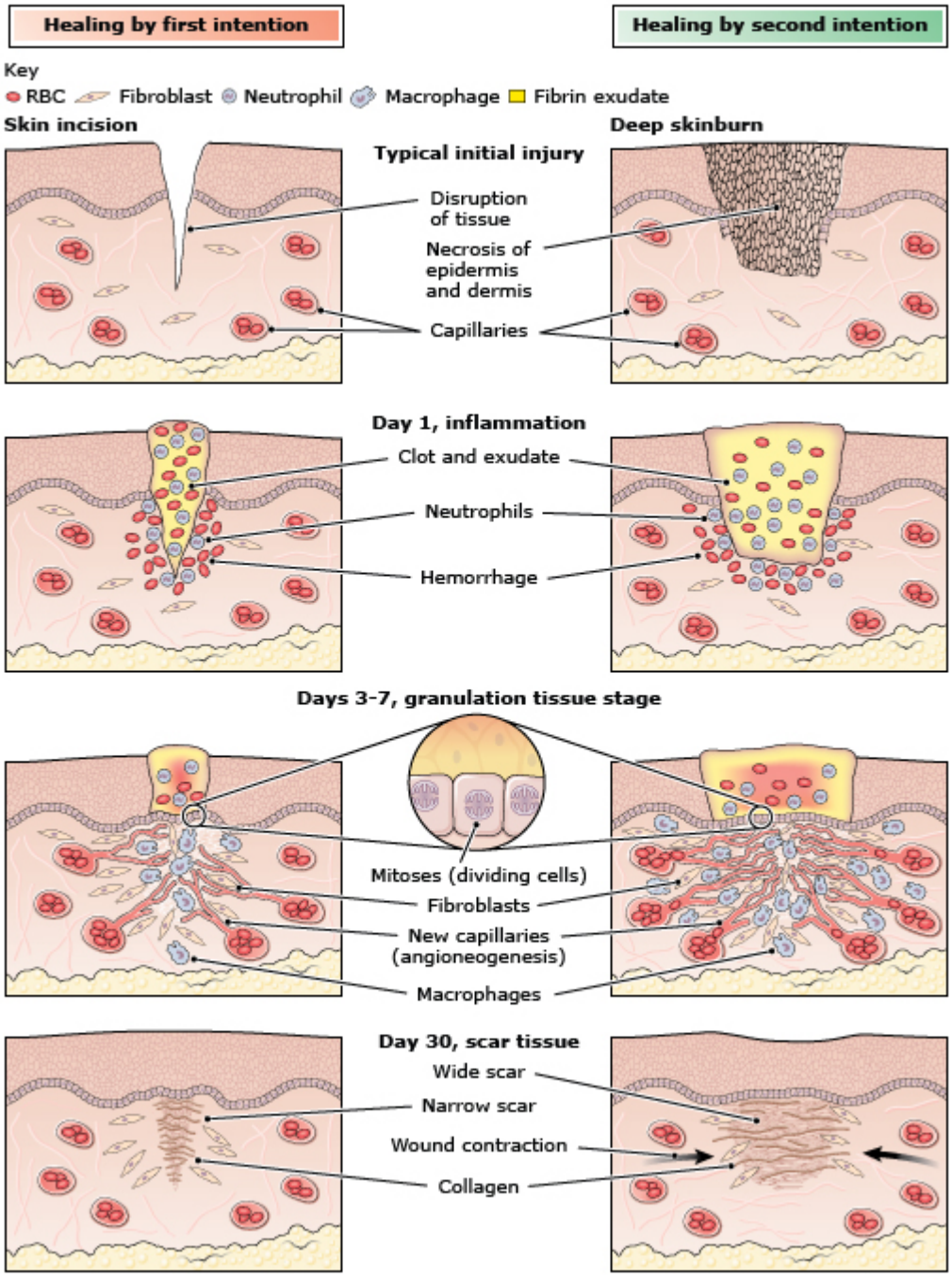
Healing by primary and secondary intention



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