Management of Acute Partial-thickness Burns

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More than 1 million burns occur annually in the United States. The management of first-degree burns is limited to minor pain control whereas third-degree burns require skin grafting. However, second-degree/partial-thickness burns disrupt the epidermis and part of the dermis, thereby requiring acute wound care, pain control, and infection control. There are many different topical treatments and dressings for acute partial-thickness burns, and the clinical superiority of any one treatment is unclear. Because dermatologists may manage acute outpatient burns, we review the most widely utilized treatments that may be administered on an outpatient basis.

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More than 1.2 million individuals in the United States each year experience burns. Of the 500,000 burn injuries that receive medical treatment, the majority require outpatient treatment and only 50,000 require hospitalization.[1,2] Children aged 2 to 4 years are reported to have the greatest frequency of burns, most commonly scald burns. The second greatest incidence rate is reported among adolescent boys and young adult males aged 17 to 25 years, most commonly burns from flammable liquids.[1]

Categorizing Burn Wounds

Triaging a burn wound requires assessment of the wound's depth and surface area. The depth is more indicative of how the wound will heal and if grafting will be needed, while the surface area is more of a determinant of how aggressively the patient must be resuscitated. The wound depth often is not apparent upon initial evaluation, and most burns are uneven in their penetration of the skin. Table 1 provides a summary of the most common burn types and their histologic description, clinical presentation, and most widely accepted treatment regimens.

First-degree burns penetrate only the epidermis without creating a remarkable barrier loss. They usually present with painful and erythematous but intact skin (Figure 1). The treatment is primarily symptomatic with topical salves and nonsteroidal anti-inflammatory drugs (NSAIDs), and complications such as scarring do not frequently occur.

Partial-thickness (or second-degree) burns consist of injury to the epidermis and some of the dermis (Figure 2). They may be further divided into superficial and deep partial-thickness burns, the former penetrating only the papillary dermis and the latter traversing further into the reticular dermis. Partial-thickness burns most commonly present as red and painful blisters that may or may not be intact. Reepithelialization typically occurs within 1 to 4 weeks from retained epidermal structures in the rete ridges, hair follicles, and sweat glands. Severe scarring may occur if there is a loss of these dermal appendages. Partial-thickness burns do not penetrate the boundary between the dermis and the subcutaneous tissue, which would categorize the injury as a full-thickness (or third-degree) burn (Figure 3). Third-degree burns require skin grafting, as the depth of the injury destroys all dermal appendages and prevents spontaneous reepithelialization from occurring.

Because the skin is a crucial barrier that prevents infection while retaining body fluids and heat, the treatment of extensive second- and third-degree burns tends to be complex, as it must address all of these lost functions. The treatment of extensive burns begins with replenishing lost fluids and preventing the loss of heat by dressing the wounds to prevent evaporation. Wound dressing also must minimize the threat of infection in nonintact skin.

There is less variability in the treatment of first- and third-degree burns, as the former require minimal wound care and the latter almost always require skin grafting. However, there is a great variety of treatments

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Table 1.

Characteristics of Major Burn Types

Burn Type	Histologic Depth	Clinical Presentation	Treatment
First degree	Epidermis	Erythematous but intact skin, no blisters, pain may range in severity	Topical salves, cold compresses, dressing, NSAIDs for pain control
Superficial second degree/partial thickness	Papillary dermis	Erythematous with superficial blisters, intense pain	Topical antimicrobials with gauze dressing or biosynthetic dressing (if widespread), pain control
Deep second degree/partial thickness	Reticular dermis	Erythematous with superficial/deep blisters, range of pain depending on nerve involvement	Topical antimicrobials with gauze dressing or biosynthetic dressing (if widespread), pain control
Third degree/full thickness	Through dermis to subcutaneous tissue	May appear white or black, possible eschar, may or may not be painful depending on nerve damage	Usually requires grafting, may require resuscitation depending on TBSA affected, pain control

Abbreviations: NSAID, nonsteroidal anti-inflammatory drug; TBSA, total body surface area.

currently utilized for second-degree/partial-thickness burns, the majority of which are not supported by strong evidence of efficacy. Because dermatologists often treat minor burns in an outpatient setting, we conducted a narrative review of the existing evidence for minor burn management. Topics reviewed include wound cleansing, pain control, wound dressings, and prevention of infection.

Overview of Partial-thickness Burn Management

As with all wounds, the management of burns involves preventing infection, facilitating healing, and maximizing cosmesis. A variety of treatments are in practice, ranging from the placement of a biosynthetic covering to the placement of gauze coupled with silver sulfadiazine.

Only a few practices for the care of partial-thickness burns are based on well-controlled, randomized clinical trials. For instance, maintaining a moist covering on the burn wound via a biosynthetic, biologic, or synthetic dressing optimizes the healing process. Acute burn wounds heal faster in a moist environment, which allows for a higher rate of keratinocyte migration, vascularization, and reepithialization.[3]

One Canadian study surveyed the most commonly utilized therapies for partial-thickness burns both before and after postburn day 5.[4] Within the first 5 days following the injury, regardless of the wound surface area, the application of silver sulfadiazine cream 1% was the primary choice by 32.7% of responders, followed by povidone-iodine (10.3%) and human allografts (10.0%). Nonbiologic occlusive dressings were favored in only 7.0% of cases. After postburn day 5, silver sulfadiazine remained the most favored treatment. No one treatment was preferred in more than 50% of cases, which demonstrates that there is a variety of therapies for this category of burns.[4]

Debridement and Cleansing

Most minor burn wounds are first cleansed with a mild nonalcoholic soap or detergent and then rinsed with normal saline. There is no evidence supporting vigorous cleansing of the wound with antiseptic solutions such as povidone-iodine.[1] Although some in vitro studies have demonstrated that

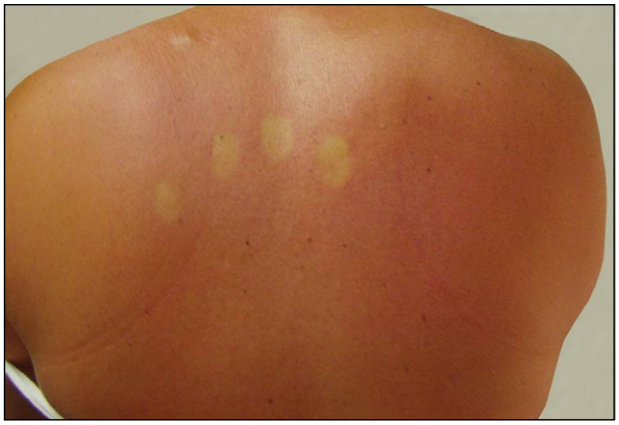

Figure 1. First-degree burn on the back with erythematous but intact skin. Photograph courtesy of Stephen M. Milner, MD, Department of Surgery, Johns Hopkins Bayview Medical Center, Baltimore, Maryland.

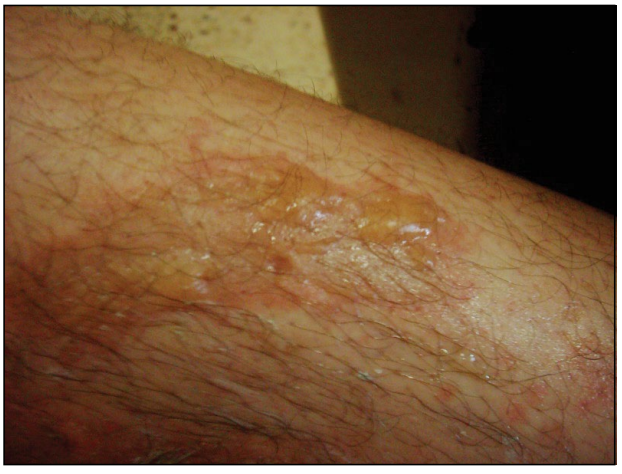

Figure 2. Second-degree/partial-thickness burn on the forearm with painful blisters. ©Naeem Alhayani, DVD, Dermatlas (http://www.dermatlas.com).

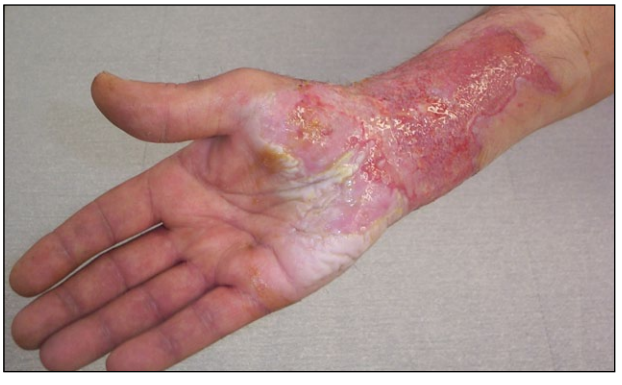

Figure 3. Third-degree/full-thickness burn on the right hand and wrist. ©Mehrdad Mehravaran, MD, Dermatlas (http://www.dermatlas.com).

povidone-iodine solution is effective against bacteria without destroying fibroblastic cells, its clinical significance in preventing wound infection is more controversial.[1,5-7]

Blisters are common wound sequelae seen in superficial partial-thickness burns. There is no universal standard regarding their care. For instance, when fibroblasts are exposed to blister fluid, they may contract prematurely and cause joint and tissue stiffness. Moreover, the cytokines of blister fluid have been shown to contribute to hypertrophic scarring. Other studies suggest that debriding a burn blister and applying a moisture-retaining dressing with a matrix or scaffold, such as a biosynthetic dressing, may optimize healing time and reduce hypertrophic scarring.[8,9] Regardless of whether a blister should be incised and drained, the exposed fluid and nonintact skin provide a rich medium for bacterial growth, and if left open, desiccation may convert a partial-thickness burn into a deeper injury.[10] To prevent desiccation and infection, nonintact skin must be covered with a wound dressing.

Pain Management

Unfortunately, pain often is undertreated in the healthcare setting. One study analyzed a database of emergency department encounters from 1992 to 1999 and found that of 1537 cases of burns, only 40% to 57% of patients received analgesics.[11]

While partial-thickness burns may produce pain of varying degrees, patients have different thresholds for pain and different physiologic responses to treatments.[12] In general, mild pain may be treated with acetaminophen or an NSAID, and moderate to severe pain should be treated with an opioid added to either acetaminophen or an NSAID.[13]

Dressings

The application of gauze with a topical antimicrobial (most commonly silver sulfadiazine) to a burn wound is still nearly universal. In addition to stimulating reepithelialization, many occlusive dressings are easier to apply and remove, require fewer dressing changes, decrease pain, decrease time to healing, and produce better cosmetic outcomes. Of the occlusive dressings, the hydrocolloids, hydrogels, and hydrofibers are most widely utilized.

Hydrocolloids consist of hydrophilic and hydrophobic components within a matrix of gelatin, pectin, and carboxymethylcellulose. When the dressing contacts the wound exudate, it forms a gel over the wound that maintains moisture and allows for autolysis to enhance granulation tissue formation. If the exudate is opaque, it may be confused with infection.

In contrast, the hydrogels consist of a hydrophilic polymer and up to 80% water. Although they allow

Table 2.

Therapies for Partial-thickness Burns

Treatment	Description	Pros	Cons	Summary of Literature Findings	Cost
Topical Therapies					
Bacitracin	Topical antimicrobial with activity against gram-positive organisms	Inexpensive, OTC, provides a moist environment for reepithelialization	Prolonged use may lead to yeast overgrowth, allergenic, does not cover *Pseudomonas aeruginosa*	Ideal for very superficial burns	$1.88 for 0.5 oz[19]
Silver sulfadiazine cream 1%[3,4,9,20]	Inexpensive, nonpainful/ soothing, broad-spectrum antimicrobial properties (VRE, MRSA, *P aeruginosa),* provides moist environment	Allergenic, may delay wound healing in more superficial burns	Best for extensive partial-thickness burns with possible *Pseudomonas* infection or a third-degree burn prior to excision and grafting	Broad-spectrum antimicrobial coverage, inexpensive	$14.96 for 20 g[21]
Povidone-iodine solution 10%[22-26]	Iodine complexed with polyvinylpyrrolidone	Broad-spectrum antimicrobial, bacteria do not form resistance	Allergenic, pruritic, may delay wound healing, systemic absorption may have renal side effects and thyroid hormone changes, rare association with chemical burns	Large side-effect profile renders it unfavorable first choice	$8.20 for 15 mL[27]

Treatment	Description	Pros	Cons	Summary of Literature Findings	Cost
Mafenide acetate solution 5%, cream 8.5%[28-30]	Antimicrobial obtained as sterile powder to be mixed with sterile saline solution	Stronger coverage of *P aeruginosa* and *Enterococcus*, penetrates burn eschars, may be used in case of resistance to silver sulfadiazine, may be applied to ears and nose to prevent chondritis	Painful on nonintact skin, risk for metabolic acidosis with high systemic absorption, does not cover yeast or fungi	Best for irrigation of meshed skin after grafting, patients with high risk for *P aeruginosa* infection, and small areas of full-thickness burns	$36.39 for 2 oz of 8.5% cream[31]
Nonbiologic Dressings					
Hydrocolloid[32,33]	Bilaminar membrane with an outer polyurethane foam layer and inner hydrocolloid polymer complex	Inner layer interacts with wound exudate to form a gel, prevents desiccation, fewer required dressing changes, may stimulate wound healing, hypoallergenic	Difficult to apply to burns on digits of hands or feet, not very beneficial for drier wounds	Efficacious for donor sites and superficial burns, good for pediatric patients	$23.33 for five 4×4-in dressings[34]
Hydrogel[35]	Nonadherent hydrogel sheet comprised of 4% insoluble cross-linked polyethylene oxide and 96% water	Ideal for all partial-thickness burns, may reduce pain	Not for use on third-degree burns, usually requires a second dressing to hold into place	May adjust to different levels of wound moisture (ie, rehydrate a dry wound, absorb exudate)	$58.19 for ten 4×4-in dressings[36]
Hydrofiber[3,14,15]	Sodium carboxymethylcellulose dressing, may come impregnated with ionic silver 1.2%	Creates a soft gel when in contact with wound fluid, highly absorbant, fewer dressing changes	Not very beneficial for drier wounds	Most beneficial for highly exudative wounds, may result in better scar cosmesis, good for pediatric patients	$108.66 for 10 sheets of 4×4-in dressings[37]

Table 2. (continued)

Treatment	Description	Pros	Cons	Summary of Literature Findings	Cost
Biologic Dressings					
Biobrane®[30,38-40]	Biosynthetic dressing, silicone film combined with a nylon fabric to produce a 3-D structure of trifilament thread, collagen is chemically bound to thread	Wound visualization, decreased time to healing, decreased infection rates due to silicone barrier	May enclose dead tissue and lead to bacterial growth if dead tissue is not debrided	Indicated for partial-thickness burns	$366.44 for five 5×5-in dressings[41]
TransCyte®[39,42,43]	Extracellular matrix of allogeneic human dermal fibroblasts on a nylon mesh provides a synthetic epidermis containing multiple growth factors	Decreased pain, decreased time to reepithelialization, ameliorates scarring, fewer required dressing changes	Expensive	Ideal for wide superficial burns with high risk for scarring, ideal for pediatric patients	$675 for a single 5×7-in piece[44]
EZ-Derm™[43]	Xenogeneic skin substitute consisting of porcine collagen cross-linked with an aldehyde	Immediate substitute before skin grafting is available, long shelf life	Risk for disease transmission, low absorptive ability, scarce clinical data, expensive	More applicable as a wound cover until skin grafting is achieved, little clinical data to support use on superficial wounds	$267.08 for 3×24-in roll[45]
Dermagraft®[43,46]	Human fibroblast–derived dermal substitute on a polyglactin mesh, secretes collagen and growth factors	Immediately available, resistant to tearing, easy to handle, lack of rejection or disease transmission	Expensive	Designed for treatment of full-thickness diabetic ulcers, unclear indication for burns	$1300 for 2×3-in dressing[47]

Abbreviations: OTC, over-the-counter; VRE, vancomycin-resistant enterococci; MRSA, methicillin-resistant *Staphylococcus aureus*; 3-D, 3-dimensional.

for necrotic debridement and autolysis similar to the hydrocolloids, they are better at rehydrating dry wounds and do not have strong absorptive ability. Hydrofibers are composed of carboxymethylcellulose and also form a gel when in contact with wound exudate. The hydrofibers are particularly beneficial for heavily exudative wounds[3,14] and have shown good improvement in scar pliability and height.[15]

Biologic and biosynthetic dressings include skin grafts and skin substitutes. Skin grafts primarily are used for third-degree burns. Skin substitutes provide scaffolding over which tissue regeneration can occur. Biosynthetic dermal substitutes initially were designed to cover burn wounds and graft sites. Formulated with functional and structural similarities to the dermis, they provide a cellular and collagenous mixture to induce epithelial migration and differentiation. However, biologic dressings may be rejected, induce an allergic response, or transmit disease.[3]

Occlusive and semisynthetic dressings may be superior over silver sulfadiazine with a dry dressing. One study evaluated a silver-impregnated hydrofiber dressing compared with silver sulfadiazine with a dry dressing and found that the former conferred a slight advantage in improving vascularity, pliability, repigmentation, and extent of reepithelialization at the end of the treatment period. However, the only significant difference was in scar height (P=.042), which was more likely to normalize in the hydrofiber group than in the silver sulfadiazine group.[16]

For less exudative wounds, hydrocolloid dressings are superior to silver sulfadiazine.[14] Biosynthetic wound dressings that provide a 3-dimensional structure for reepithelialization also have been shown to be superior to silver sulfadiazine in decreasing limitation of activity, improving patient compliance, decreasing healing time, requiring fewer dressing changes, and producing improved repigmentation of the injured skin.[17,18]

There is a wide variety of dressing options for acute partial-thickness burns (Table 2). Overall, the occlusive dressings offer improvements in wound healing and scar cosmesis for minor burns. Nonetheless, they are expensive and their clinical superiority may not outweigh their expense for the majority of outpatient minor burns.

Infection Control

Burned patients harbor an increased risk for infection for several reasons. First, the loss of the protective skin barrier confers a remarkable level of immunosuppression.[10,48] Second, the colonization of burn wounds with the natural flora of the skin, such as *Staphylococcus epidermidis*, is unavoidable and burn wounds are inevitably contaminated. Third, thermal injury produces coagulation necrosis that, once infected, behaves similarly to an undrained abscess and renders antibiotics less effective.

Furthermore, recognizing infection may be challenging because an infected wound may be clinically indistinguishable from a healing burn. As the burn wound heals, it often presents with notable erythema, edema, pain, and even leukocytosis or a low-grade fever.[10]

The reported rates of wound infections vary greatly among studies because standardized criteria for infection are not well-defined. However, regardless of infection criteria, many reports on the incidence of hospital-acquired infection among burn patients have determined that the percentage of total body surface area affected is a clinically significant risk factor.[48-50]

The predominant bacteria that cause infection in burn patients are *Pseudomonas aeruginosa* and *Staphylococcus aureus*, including methicillin-resistant *S aureus* (MRSA).[51] Colonization with MRSA is associated with larger burns, twice as many operative procedures, and prolonged hospital admission.[52] Methicillin-resistant *S aureus* and methicillin-resistant *S epidermidis* together account for 82% of gram-positive wound isolates, whereas gram-negative bacteria account for only 34%.[52-55]

Prophylactic oral antibiotics generally are not recommended, unless the patient is undergoing a skin graft.[10] The majority of treatments to prevent infection are comprised of topical antimicrobials, though their efficacy is questionable because widespread use has led to increasing bacterial resistance.[49] Although research has not demonstrated a notable benefit from applying most topical antimicrobials to minor burn wounds, the use of antiseptic-impregnated dressings and newer topical treatments such as cadexomer iodine and silver delivery systems may be more efficient in preventing infection.[7,56]

Topical Antimicrobials

Silver sulfadiazine has broad-spectrum antimicrobial properties and remains effective against some of the most resistant bacteria such as vancomycin-resistant enterococci and MRSA. Its wide use prevails despite reported side effects such as hypersensitivity reactions, allergic contact dermatitis, neutropenia, erythema multiforme, methemoglobinemia, and cutaneous argyria. Although a few cases of localized argyria have been reported, the deposition of silver within the skin from the short-term use of silver sulfadiazine is uncommon.[20]

In contrast to occlusive dressings, silver sulfadiazine applied to superficial to mid-thickness burns may result in delayed wound healing and exacerbation of scarring. All topical antimicrobials are variably

detrimental to wound healing. For instance, even in low concentrations, povidone-iodine inhibits the chemotaxis of polymorphonuclear leukocytes.[4] Gauze-based materials and dressings must be changed daily and they tend to adhere to the wound bed, causing pain and damage to reepithelialization when removed. Silver sulfadiazine causes an accumulation of proteinaceous debris that prevents the inward migration of fibroblasts and epithelial cells. The damage from the debris is augmented by the mechanical trauma of daily dressing changes. For this reason, silver sulfadiazine may be beneficial only when used as an antimicrobial on deeper partial-thickness burns.[9]

Despite the negative reputation of the topical antimicrobials, some may have a remarkable benefit. Mafenide acetate has 2 major advantages over silver sulfadiazine. It is more effective than silver sulfadiazine against resistant *Pseudomonas* and *Enterococcus* species, and it can penetrate eschars. However, mafenide acetate also is painful on application and inhibits carbonic anhydrase, which may cause metabolic acidosis if applied over a large surface area of skin. Therefore, mafenide acetate is applied primarily to burn eschars and small areas of full-thickness burns.[28,29]

Conclusion

Patients with acute minor burns may be seen by a dermatologist for initial evaluation and outpatient management. The most practical treatment of the majority of acute partial-thickness burns is the application of bacitracin or silver sulfadiazine because the high cost of occlusive dressings may outweigh their clinical superiority for many patients. For patients who find frequent dressing changes impractical or painful, occlusive hydrocolloid dressings may be beneficial or, for more exudative wounds, a hydrofiber dressing. For pediatric patients who do not require referral to a burn center, the clinician may consider administering a collagen-based dressing or skin substitute. In these cases, the superiority of the dressings would outweigh the disadvantages of increased cost. However, for a small burn (<1% total body surface area), the clinical necessity may fail to outweigh the cost.

All burn patients must be carefully assessed for pain. Acetaminophen or an NSAID may relieve minor discomfort, but an opioid may be necessary for severe pain. Traditional gauze dressings should be changed twice daily and topical antimicrobials reapplied. Synthetic dressings may be changed less frequently, depending on the exudative nature of the wound and properties of the dressing. There is currently no strong evidence that prophylactic oral antibiotics are advantageous. Evidence-based protocols for partial-thickness burns are still lacking, reflecting a paucity of research in this area.

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