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Strategies for Wound Burn Healing

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ABSTRACT

The World Health Organization (WHO) indicates that more than 11 million people sustain burns each year, leading to 180,000 deaths. A burn is a condition caused by heat, chemical agents, electrical currents, or other forces that damage tissue. Burns primarily affect the skin, but they may also involve deeper structures, such as bones and muscles. Upon combustion, the skin relinquishes its fundamental functions, including protection against environmental threats, infections, moisture loss, and thermal regulation. It is imperative to select the most appropriate therapy based on the burn's stage, the patient's health, and the burn's etiology. Personalization and interdisciplinary collaboration are crucial for the effective treatment of burn victims. This comprehensive study consolidates and analyzes the available treatment modalities, highlighting recent advancements in topical therapies, wound debridement, dressings, skin grafting, nutritional support, pain management, and scar tissue treatment.

KEYWORDS: thermal injuries; burn management; regenerative therapies; dermal grafts; tissue engineering; wound dressings Preface

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Burns constitute some of the most severe and excruciating injuries, frequently affecting infants, individuals with disabilities, and the elderly, whose demographic is increasing in aging nations. Burns constitute the fourth most common category of injury, following road traffic accidents, falls, and acts of physical violence. Climate change and rising temperatures are contributing to an increase in sunburn occurrences, which are associated with various skin cancers, including melanoma.

In recent decades, numerous burn treatment facilities have been established, providing specialized care and aiding in the decrease of mortality rates. Despite significant progress, burn treatment is considered burdensome due to numerous complications and prolonged hospitalization. Moreover, the increasing prevalence of patients with severe burns presents further challenges, encompassing post-traumatic care, scar management, and the treatment of psychological disorders, as patients frequently display post-traumatic stress disorder (PTSD).

Burns involving more than 30% of the total body surface area (TBSA) lead to burn shock. The consequences of burns are significantly severe, as the skin is the largest organ in the human body, accounting for approximately 8% of total body weight. The human skin covers an area of 1.2 to 2.2 m² and possesses a thickness between 0.5 and 4.0 mm. The structure comprises multiple layers: the outer epidermis, the dermis (which includes the papillary and reticular layers), and the subcutaneous tissue, each serving specific physiological functions.

A burn is a condition defined by the compromise of the skin barrier resulting from external thermal, chemical, or electrical agents. When the skin's integrity is compromised, its functions are hindered, heightening vulnerability to dehydration, infection, metabolic disorders, or even death. The injured area is histologically classified into three zones, as defined by Jackson in 1947. The skin possesses considerable regenerative capabilities; however, when injured beyond the reticular dermis, its regenerative capacity declines. The wound healing process consists of three distinct phases: inflammation, marked by coagulation, cytokine release, chemotaxis, and cell recruitment; proliferation, involving dermal resurfacing with angiogenesis and fibroplasia; and maturation, which includes the extracellular matrix. The suturing of the incision results in the formation of scar tissue. During this final stage of recovery, there is a risk of hypertrophic scarring, leading to contractions.

The healing duration for burn wounds depends on their severity, classified as superficial, shallow partial, deep partial, or full thickness. Superficial burns impacting the epidermis, although painful (second-degree), resolve within weeks without scarring. Conversely, deep wounds necessitate prolonged healing periods owing to the damage to the extracellular matrix (ECM), degradation of growth factors (GFs), extended inflammatory phase, increased pro-inflammatory cytokines, proteases, reactive oxygen species (ROS), and the risk of infection. Burns can be classified into four principal categories based on the depth of penetration, which is affected by exposure temperature, duration of contact, source of exposure, and skin thickness.

Figure 1. Partial thickness mesh graft for management of deep second and third degree burns

Tissue Regeneration

Currently, no burn dressing is widely utilized that guarantees complete healing without requiring frequent dressing changes, additional surgery, or skin grafts. The treatment protocol consists of several stages, starting with conservative therapies for burn shock and wound protection, followed by surgical procedures involving tissue excision and closure with skin grafts. This approach causes stress in patients and does not guarantee successful recovery or survival. Researchers are rigorously seeking the ideal standard in burn treatment to improve and accelerate the healing process while minimizing the risk of infection. Prompt wound decontamination is essential for effective treatment. This can be achieved through surgical methods to remove necrotic tissue from the wound or through conservative approaches employing specialized dressings like hydrogels, hydrocolloids, or enzymatic debridement techniques. Moreover, when significant burns exceed 30% of the body surface area, appropriate graft sources must be determined. The most effective approach for burn coverage is the use of autologous split-thickness skin grafts (STSGs) obtained from an intact donor site, potentially enhanced by meshing or the Meek technique for complete wound coverage. Many skin harvesting sites for autografting are unsightly and require wound healing and adjunctive therapy. However, when intact skin is inadequate, allografts and xenografts serve merely as temporary wound coverings due to the risk of transplant rejection. Current efforts focus on developing specialized artificial skin substitutes using biological, synthetic, and biosynthetic materials to enable the primary and permanent closure of burn wounds, reduce scarring, and shorten treatment duration and costs, notwithstanding the various advantages of different skin grafts.

Figure 2. Placement of Epifast for superficial second-degree burn

Figure 3. Suprathel placement in deep second degree burn

Escharotomy

When circumferential eschar encircles anatomical structures, particularly the fingers, extremities, abdomen, thorax, or neck, the underlying tissues endure increased pressure. The pressure is exacerbated by the emergence of edema within the initial 4 to 6 hours following the injury. As interstitial pressure escalates, it initially impedes venous blood outflow and subsequently obstructs arterial blood influx. The result is dysfunction, ischemia, or necrosis in or distal to the affected anatomical structures, frequently arising abruptly. In the extremities, it may lead to nerve and muscle degeneration, resulting in chronic functional impairment or requiring surgical interventions such as amputation. In the abdominal region, impaired blood circulation to the intestines, kidneys, and other internal organs results in the rapid onset of liver and kidney failure, bowel ischemia, and reduced diaphragmatic mobility. Abdominal compartment syndrome (ACS), caused by intra-abdominal hypertension (IAH), can also occur as a result of burn injuries. Acute Cholecystitis Syndrome (ACS) may be treated with fluid resuscitation alongside continuous venovenous dialysis and ultrafiltration, or through immediate surgical decompression via laparotomy. Escharotomy is a surgical procedure aimed at relieving constriction caused by eschar, thereby restoring adequate perfusion and normal function to the affected tissues and organs. In numerous cases, a solitary incision does not sufficiently relieve the constricting eschar. Thus, it is standard practice to execute bilateral escharotomy incisions on the trunk or medially and laterally on each affected limb.

The World Health Organization (WHO) recommends conducting escharotomy within the first 48 hours as a component of the initial management of burn injuries. Most specialists contend that prompt surgical intervention, ideally within 6 hours of symptom onset, is beneficial, while delaying treatment leads to considerable sepsis complications. A restricted number of studies caution against early surgical intervention owing to possible iatrogenic effects.

Figure 4. Dermofasciotomy in right second and third degree burn to prevent compartment syndrome

Figure 5. Dermofasciotomy on right foot with second and third degree burns to prevent compartment syndrome

Debridement

The debridement procedure commences with the cleansing of the surrounding skin utilizing soap, disinfectant, or povidone iodine, and shaving the hair if necessary. The wound is subsequently irrigated and disinfected with 0.1% benzalkonium chloride or 0.05% chlorhexidine. Meticulous debridement procedures are employed to diminish inflammation. Completely remove detached non-viable epithelium from ruptured blisters and debris. In superficial partial-thickness burns, large blisters may be drained, while small blisters should remain unbroken. In instances of severe cutaneous burns, especially those caused by hot liquids, the loosely adhering epithelium must be surgically removed.

Routine debridement has been demonstrated to expedite healing by reducing the activity of proteases that degrade growth factors. Cleaning wounds within the initial 24 to 48 hours may reduce the likelihood of invasive burn infections, particularly in pediatric patients. Surgical debridement involves the removal of healthy tissue and the modification of the wound's configuration, thereby increasing the wound surface area. Moreover, it requires specialized treatment and intravenous analgesia. Currently, alternative methods for the excision of necrotic epidermis are recommended, including hydrosurgery, larval therapy, laser treatment, and specialized cauterization systems. A significant method for non-surgical burn debridement entails the application of minimally invasive enzymatic debridement utilizing proteolytic enzymes.

4.3 Targeted Therapy

Studies demonstrate that the primary source of contamination in initial burn wounds is the indigenous skin flora, specifically staphylococci, streptococci, and methicillin-resistant Staphylococcus aureus (MRSA). Pseudomonas aeruginosa and Escherichia coli have been detected in chronic wounds, frequently within the deeper dermal strata. Research indicates that chronic wounds may be simultaneously colonized by multiple pathogens, leading to the development of bacterial biofilms. Bacterial biofilms, enveloped in a protective extracellular polymer, sustain chronic inflammation, obstruct epithelial regeneration, and provide a barrier against antibiotic treatment and the host's immune response.

Topical antimicrobials are offered in the forms of creams, ointments, and lotions. Burn centers frequently have particular preferences regarding dressings. Silver sulfadiazine (SSD) is the predominant topical antibacterial agent, exhibiting effectiveness against Staphylococcus and Streptococcus, and has been widely utilized in burn wound management since 1968.

Polyhexanide is utilized in various burn treatment facilities. A 2017 study confirmed the effectiveness of polyhexanide-betaine gel compared to silver sulfadiazine in the treatment of partial-thickness burn wounds, showing improved results in healing duration, infection rates, bacterial colonization rates, and pain assessments ($p < 0.001$).

In addition to its antibacterial properties, polyhexanide offers several benefits, including pain relief for wounds, reduction of wound odor, promotion of granulation tissue formation, and stimulation of keratinocyte and fibroblast activity.

Topical therapies encompass povidone-iodine, mafenide acetate/silver nitrate/sodium hypochlorite, exhibiting broad-spectrum efficacy against Gram-negative and Gram-positive bacteria, as well as nystatin, which possesses antifungal properties. Bacitracin, neomycin, mupirocin, and polymyxin B ointments are frequently employed for the management of superficial wounds.

Aloe vera gel (Asphodelaceae) has a longstanding history of medicinal application originating from ancient civilizations. A plethora of studies has been conducted over the years to investigate its pharmacological properties, encompassing antibacterial, antiviral, anticancer, antioxidant, and anti-inflammatory effects.

Studies have shown that Albizia julibrissin, Arnebia euchroma, Betula pendula, Betula pubescens, Centella asiatica, Hippophaë rhamnoides, and Juglans regia offer advantages over silver sulfadiazine cream, such as enhanced healing, diminished pain and burning sensations, and an elevated rate of wound epithelialization, among other benefits.

CONCLUSIONS

Recent technological advancements have improved the efficacy of burn care, resulting in a reduction of burn-related fatalities. Notable progress has been made in biomaterials and tissue engineering; however, an ideal biomaterial that mimics the skin's architecture and reinstates its function, pigmentation, appendages, blood vessels, and nerves has yet to be created. Randomized studies in large populations are essential to evaluate the effectiveness of experimental treatments utilizing innovative dressings and skin substitutes. Acellular and cellular tissue-engineered skin constructs appear to be promising. Current research trends focus on creating a skin substitute by rapidly cultivating stem cells on specialized polymeric substrates, designed to cover wounds and function as bioactive dressings that improve wound functionality and accelerate healing.

REFERENCES

I. Hussain, Z., Thu, H. E., Rawas-Qalaji, M., Naseem, M., Khan, S., & Sohail, M. (2022). Recent developments and advanced strategies for promoting burn wound healing. *Journal of Drug Delivery Science and Technology*, *68*, 103092.

II. Mirhaj, M., Labbaf, S., Tavakoli, M., & Seifalian, A. M. (2022). Emerging treatment strategies in wound care. *International Wound Journal*, *19*(7), 1934-1954.

III. Greenhalgh, D. G. (2024). Basic techniques for optimizing burn wound healing: insights from clinical practice. *Plastic and Aesthetic Research*, *11*, N-A.

IV. Markiewicz-Gospodarek, A., Kozioł, M., Tobiasz, M., Baj, J., Radzikowska-Büchner, E., & Przekora, A. (2022). Burn wound healing: clinical complications, medical care, treatment, and dressing types: the current state of knowledge for clinical practice. *International journal of environmental research and public health*, *19*(3), 1338.

V. Liang, Y., He, J., & Guo, B. (2021). Functional hydrogels as wound dressing to enhance wound healing. *ACS nano*, *15*(8), 12687-12722.

VI. Raina, N., Rani, R., Pahwa, R., & Gupta, M. (2022). Biopolymers and treatment strategies for wound healing: an insight view. *International Journal of Polymeric Materials and Polymeric Biomaterials*, *71*(5), 359-375.

VII. Nourian Dehkordi, A., Mirahmadi Babaheydari, F., Chehelgerdi, M., & Raeisi Dehkordi, S. (2019). Skin tissue engineering: wound healing based on stem-cell-based therapeutic strategies. *Stem cell research & therapy*, *10*, 1-20.

VIII. Wang, G., Yang, F., Zhou, W., Xiao, N., Luo, M., & Tang, Z. (2023). The initiation of oxidative stress and therapeutic strategies in wound healing. *Biomedicine & Pharmacotherapy*, *157*, 114004.

IX. Farahani, M., & Shafiee, A. (2021). Wound healing: from passive to smart dressings. *Advanced Healthcare Materials*, *10*(16), 2100477.

X. Kolimi, P., Narala, S., Nyavanandi, D., Youssef, A. A. A., & Dudhipala, N. (2022). Innovative treatment strategies to accelerate wound healing: trajectory and recent advancements. *Cells*, *11*(15), 2439.