

Current Classification of Burns and Management Strategies According to Depth and Etiology: A Narrative Review

Regina Gallardo Santiago^{*1}, Marisela Silva García², Martín S. Rodríguez-Garza³, Alhan Fernando Castillo Valencia⁴, Jorge Eduardo Méndez Chávez⁵, Luis J. Castillo-Gaxiola⁶, Brayan J. Benguechea-Santiago⁶

¹Hospital Ángeles, Morelia, Michoacán, México.

²Hospital General Dr. Miguel Silva, Morelia, Michoacán, México.

³ISSSTE Regional de Monterrey, Monterrey, Nuevo León, México.

⁴Hospital Regional Universitario de Colima, Colima, México.

⁵Clínica Sagrado Corazón, Tizapán el Alto, Jalisco, México.

⁶Instituto Mexicano del Seguro Social, Hospital General de Zona No. 35, Ciudad Juárez, Chihuahua, México.

ABSTRACT

Background: Burn injuries remain a major global health concern and are associated with significant morbidity, mortality, and long-term disability. Accurate classification of burns according to depth, total body surface area (TBSA), and etiology is essential for guiding clinical decision-making and determining appropriate management strategies.

Objective: To review current concepts in burn classification based on depth and etiology and summarize contemporary management strategies and emerging diagnostic technologies.

Methods: A narrative review of the literature was conducted focusing on studies addressing burn classification, diagnostic assessment, and treatment strategies. Key topics included depth-based classification systems, etiological categories of burn injuries, advances in burn depth assessment technologies, and current management approaches across the continuum of burn care.

Results: Burn injuries are primarily classified into superficial, superficial partial-thickness, deep partial-thickness, and full-thickness categories, each associated with distinct clinical features and healing potential. Burn severity is further determined by TBSA involvement and anatomical location, which guide triage decisions and referral to specialized burn centers. Etiological classification—including thermal, chemical, electrical, and radiation burns—plays a critical role in tailoring management strategies. Advances in imaging technologies such as laser Doppler imaging, hyperspectral imaging, and artificial intelligence-based diagnostic systems have improved the accuracy of burn depth assessment. Current treatment approaches range from conservative wound care using advanced moist dressings for superficial injuries to early excision and skin grafting for deeper burns. Emerging regenerative therapies, including tissue-engineered skin substitutes and biomaterial-based dressings, offer promising opportunities to enhance wound healing and reduce long-term complications.

Conclusion: Burn classification based on depth, TBSA, and etiology remains fundamental for guiding clinical management. While traditional clinical assessment continues to play a central role, emerging diagnostic technologies and regenerative therapies may significantly improve treatment outcomes. Continued research is necessary to integrate these innovations into standardized burn care protocols and optimize patient recovery.

KEYWORDS: Burn injuries; Burn classification; Burn depth; Total body surface area (TBSA); Burn etiology; Burn wound management; Skin grafting; Advanced wound dressings; Burn wound healing; Regenerative medicine.

ARTICLE DETAILS

Published On:
20 May 2026

Available on:
<https://ijmscrs.com>

INTRODUCTION

Burn injuries represent a significant global health problem and are associated with considerable morbidity, mortality, and long-term functional impairment. In addition to local tissue destruction, burns trigger systemic responses including oxidative stress, inflammation, metabolic dysregulation, and increased susceptibility to infection, all of which may compromise tissue repair and recovery (1). Effective burn management therefore requires accurate classification systems that guide early clinical decision-making and therapeutic strategies.

Traditionally, burn injuries are categorized according to depth of tissue damage, total body surface area (TBSA), and etiological mechanism, which together determine severity and appropriate management (2). These classifications are essential for determining whether burns can be managed conservatively or require specialized surgical treatment.

In recent decades, advances in wound care, diagnostic technologies, and regenerative medicine have significantly expanded therapeutic options in burn care. Modern approaches increasingly incorporate advanced imaging, innovative biomaterials, and tissue engineering strategies to optimize healing and minimize long-term complications such as infection, scarring, and contracture formation (3–5).

This narrative review summarizes the current understanding of burn classification according to depth and etiology and discusses contemporary management strategies and emerging diagnostic and therapeutic technologies.

LITERATURE REVIEW

Burn Classification According to Depth

Burn depth is one of the most important determinants of prognosis and management. The widely accepted clinical classification divides burns into superficial, superficial partial-thickness, deep partial-thickness, and full-thickness injuries (6).

Superficial burns affect only the epidermis and typically present with erythema and pain without blister formation. These injuries usually heal within approximately one week without scarring and require minimal intervention such as analgesia and protective dressings (7).

Superficial partial-thickness burns extend into the papillary dermis and commonly present with blistering, significant pain, and brisk capillary refill. These wounds generally heal within two to three weeks with a low risk of permanent scarring. Treatment focuses on maintaining a moist wound environment using advanced dressings such as hydrogels, hydrocolloids, or film dressings to promote epithelialization and prevent infection (8).

Deep partial-thickness burns involve the reticular dermis and are characterized by pale tissue, reduced sensation, and sluggish capillary refill. Healing may take three to six weeks, and these injuries have a higher risk of hypertrophic scarring. If spontaneous healing within three weeks is unlikely, early

surgical excision and skin grafting are recommended to improve functional and aesthetic outcomes (6).

Full-thickness burns involve complete destruction of the dermis and skin appendages, producing dry, leathery, and insensate tissue that cannot regenerate spontaneously. Standard treatment involves early excision of necrotic tissue followed by autologous skin grafting or the use of skin substitutes and dermal matrices (4).

More severe injuries may extend beyond the dermis to involve fascia, muscle, or bone, sometimes referred to as fourth-degree burns, which may require extensive surgical reconstruction or even amputation (2).

Histological evaluation has also been explored as a method for improving diagnostic accuracy. A large biopsy-based algorithm demonstrated that clinical assessment alone may lead to overtreatment, with approximately 20% of wounds incorrectly classified as requiring surgical excision (9).

Burn Severity and Total Body Surface Area

Burn severity is determined not only by depth but also by the percentage of total body surface area involved. Clinical guidelines categorize burns into minor, moderate, and major injuries, incorporating factors such as TBSA, burn depth, patient age, and anatomical location (10).

Minor burns involve limited TBSA and superficial injuries and can often be managed on an outpatient basis. Moderate burns typically require hospital admission for monitoring and wound care. Major burns involve extensive TBSA, deep burns, burns affecting critical anatomical areas such as the face, hands, feet, or perineum, or injuries associated with inhalation damage (7).

Severe burns may trigger systemic complications including burn shock, metabolic disturbances, and immune dysfunction, requiring aggressive fluid resuscitation and intensive care management (11).

Classification According to Etiology

Burn injuries are also categorized according to their causative mechanisms, which influence both clinical presentation and management strategies (2).

Thermal burns, including flame, scald, contact, and steam injuries, represent the majority of burn cases worldwide. Treatment strategies are primarily determined by burn depth and TBSA involvement (2).

Chemical burns result from exposure to corrosive substances such as acids or alkalis. Immediate and extensive irrigation is essential to remove the chemical agent and limit further tissue damage (12).

Electrical burns may present with minimal external injury but can cause extensive deep tissue damage involving muscles, nerves, and internal organs. These injuries require monitoring for arrhythmias, rhabdomyolysis, and compartment syndrome (3).

Radiation burns, including sunburn or exposure to ionizing radiation, often affect superficial layers but may cause delayed tissue damage in certain cases (2).

Current Classification of Burns and Management Strategies According to Depth and Etiology: A Narrative Review

Other mechanisms such as friction injuries and cold-related burns share features with both thermal and ischemic injuries and require individualized management strategies (2).

Table 1. Classification of Burn Injuries According to Depth, Clinical Features, Healing Potential, and Management Strategies Advances in Burn Depth Assessment

Burn Depth	Traditional Degree	Tissue Involvement	Clinical Features	Healing Time	Scarring Risk	Recommended Management
Superficial	First-degree	Epidermis only	Erythema, pain, dry skin, no blistering	≤ 7 days	None	Analgesia, moisturizers, protective dressings, outpatient care
Superficial Partial-Thickness	Second-degree (2A)	Epidermis + papillary dermis	Blisters, moist surface, intense pain, brisk capillary refill	10–21 days	Low	Moist wound environment, advanced dressings (hydrogels, hydrocolloids, film dressings), infection prevention
Deep Partial-Thickness	Second-degree (2B)	Epidermis + reticular dermis	Pale or mottled appearance, reduced sensation, sluggish capillary refill	3–6 weeks	Moderate–High	Burn center referral, close monitoring, early tangential excision and split-thickness skin grafting if healing >3 weeks expected
Full-Thickness	Third-degree	Entire dermis destroyed; adnexal structures lost	Dry, leathery (eschar), insensate skin, no capillary refill	No spontaneous healing	High	Early excision of necrotic tissue and autologous skin grafting; dermal substitutes or skin substitutes when required
Beyond Full-Thickness	Fourth-degree	Extends into fascia, muscle, or bone	Charred tissue, extensive necrosis, severe functional damage	Not possible without surgical intervention	Very high	Aggressive debridement, complex reconstruction, possible amputation

Accurate determination of burn depth remains challenging, and clinical examination alone may be only 50–80% accurate, particularly in partial-thickness burns (13).

To improve diagnostic accuracy, several advanced imaging modalities have been developed. Techniques such as laser Doppler imaging, hyperspectral imaging, near-infrared imaging, optical coherence tomography, and spatial frequency domain imaging allow clinicians to assess perfusion, oxygenation, and structural changes in burn wounds (13).

Recent developments in artificial intelligence have also shown promising results. Machine learning algorithms combined with terahertz spectral imaging have demonstrated high accuracy in distinguishing burn depths regardless of etiology (14,15). Similarly, deep convolutional neural networks have been developed to automatically classify burn injuries using digital images, providing potential decision-support tools for clinicians (16).

Current Burn Management Strategies

Management of burn injuries involves a continuum of care beginning with emergency stabilization and progressing to definitive wound closure and rehabilitation (3).

Initial treatment follows trauma management principles, including removal of the injuring agent, airway assessment, stabilization of breathing and circulation, and prevention of burn shock. Early fluid resuscitation using formulas such as the Parkland formula is commonly employed in major burns (10).

Local wound care varies according to burn depth. Superficial and superficial partial-thickness burns are typically treated with advanced moist dressings that maintain a favorable healing environment and reduce infection risk (8).

Deep partial-thickness and full-thickness burns often require surgical intervention. Early excision of necrotic tissue followed by skin grafting remains the gold standard treatment and reduces infection risk while accelerating wound closure (4).

Emerging regenerative therapies aim to improve outcomes by restoring skin architecture and reducing scarring. These include tissue-engineered skin substitutes, stem cell

Current Classification of Burns and Management Strategies According to Depth and Etiology: A Narrative Review

therapies, platelet-rich plasma, and nanotechnology-based wound dressings (5,17). Such approaches may accelerate re-

epithelialization and improve both functional and aesthetic recovery (18).



Figure 1. deep second-degree scald burn with high-density liquid



Figure 2 Application of skin grafts in special áreas

DISCUSSION

Burn classification systems based on depth, TBSA, and etiology remain fundamental for guiding clinical decision-making. These parameters influence triage, therapeutic strategies, and expected outcomes.

Depth classification is particularly important for determining the likelihood of spontaneous healing. Superficial injuries typically respond well to conservative management, whereas deeper burns frequently require surgical excision and grafting to prevent infection, delayed healing, and hypertrophic scarring (6).

Current Classification of Burns and Management Strategies According to Depth and Etiology: A Narrative Review

Despite its clinical importance, burn depth assessment remains challenging. Clinical examination may be inaccurate, particularly in partial-thickness burns. Histological algorithms and advanced imaging technologies may improve diagnostic precision and reduce unnecessary surgical intervention (9,13).

Additionally, regenerative medicine and biomaterial-based therapies have expanded the therapeutic landscape of burn care. Tissue engineering, stem cell therapy, and advanced wound dressings show promise for improving wound healing and reducing long-term complications (5,17).

However, widespread clinical implementation of these technologies remains limited by cost, availability, and lack of standardized protocols. Future research should focus on validating these approaches and integrating them into standardized treatment algorithms.

CONCLUSION

Burn injuries require a structured and systematic approach to classification and management. Depth, TBSA, and etiology remain the key determinants guiding treatment strategies and predicting clinical outcomes.

While traditional clinical assessment remains central to burn evaluation, emerging imaging technologies and artificial intelligence tools may significantly improve diagnostic accuracy. Additionally, regenerative medicine and advanced biomaterials offer promising therapeutic opportunities for improving healing and minimizing long-term complications. Further research integrating innovative diagnostic methods with advanced therapeutic strategies is necessary to optimize burn care and reduce the global burden of burn injuries.

REFERENCES

- I. Żwierello W, et al. Burns: Classification, Pathophysiology, and Treatment: A Review. 2023.
- II. Abazari M, et al. A Systematic Review on Classification, Identification, and Healing Process of Burn Wound Healing. 2020.
- III. Kiwan O, et al. Assessment of Burns and Initial Management. British Journal of Hospital Medicine. 2025.
- IV. Markiewicz-Gospodarek A, et al. Burn Wound Healing: Clinical Complications, Treatment, and Dressing Types. 2022.
- V. Stone R, et al. Advancements in Regenerative Strategies Through the Continuum of Burn Care. 2018.
- VI. Papini R. Management of Burn Injuries of Various Depths. 2004.
- VII. Lanham JS, et al. Outpatient Burn Care: Prevention and Treatment. 2020.
- VIII. Cook KA, et al. Hydrogels for the Management of Second-Degree Burns. Burns & Trauma. 2022.
- IX. Phelan H, et al. Histologic Algorithm for Burn Depth Categorization Based on 816 Biopsies. J Burn Care Res. 2021.
- X. Rossella E, et al. Burns: Classification and Treatment. 2022.
- XI. Vaughn L, et al. Severe Burn Injury and Burn Shock. J Vet Emerg Crit Care. 2012.
- XII. Nguyen AM, et al. Paediatric Chemical Burns: A Clinical Review. Eur J Pediatr. 2021.
- XIII. Harris ZB, et al. Imaging Technologies for Clinical Assessment of Burns. 2025.
- XIV. Osman OB, et al. Deep Neural Network Classification of Burn Injuries Using Terahertz Spectral Imaging. 2022.
- XV. Osman OB, et al. THz Time-Domain Spectral Imaging for Burn Classification. 2021.
- XVI. Khan FA, et al. Computer-Aided Diagnosis for Burnt Skin Images Using Deep CNN. 2020.
- XVII. Siu WS, et al. Advancements in Facilitation of Burn Wound Healing. 2025.
- XVIII. Cretu A, et al. Strategies for Optimizing Acute Burn Wound Therapy. 2025.