

# Burn Injuries and Burn Care

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## IMPROVEMENTS IN BURN CARE

The improvements in the care of the thermally injured patient exemplify modern medicine at its finest. A telling example is the reduced lethality of burns when patients are cared for in modern burn units. A simple way to describe lethality is to look at the size of burn that has a 50/50 chance of ending with mortality: the **Lethal Dose 50 – LD50**. Since mortality from thermal injury is also age-dependent, one also should account for age in any description of burn mortality. In 1950 the LD50 for a 21 year-old was 40%. Currently that number is 90% in most burn centers. The improvements in LD50 came from a commitment to excellence in burn centers and a process of examining clinical outcomes and looking for solutions with both laboratory and clinical research endeavors that began in the 1940s and 1950s.

The improvements have been incremental but steady. The understanding of the forces that drove burn edema led to the development of burn resuscitation strategies, the Parkland and Brooke formulas in the 1950s, that predicted, for instance, that a 70kg patient, with a 70% **total body surface area (TBSA)** burn would need between 10 to 20 liters of intravenous fluid resuscitation in the first 24 hours. Adoption of these guidelines essentially eliminated acute renal failure in most burn patients. With the reduction of renal failure many larger burn patients survived their initial care. With these larger percent TBSA burn patients surviving longer, gram negative sepsis arising from the burn wound became a significant cause of mortality. Again, laboratory and clinical science led to the development of effective antimicrobial creams, silver sulfadiazine and mafenide acetate in the mid to late 1960s, which reduced bacterial density of the burn wound. These improved topical antimicrobials and the recognition that patients with large burns should be placed in protective isolation to prevent cross-contamination of their bacterial flora to other patients reduced the incidence of gram negative sepsis.

Over the next 30 years many other advancements in the care of the thermally injured patient occurred. Early excision and grafting of the wound, where all full thickness eschar is removed by 2 weeks post-burn, replaced the practice of letting the wound suppurate and grafting on a granulating wound bed at 4-6 weeks after burn.

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Evolution of medical science also helped burn patients. For example, the modern blood bank was essential to the application of early excision and grafting techniques. Better understanding of the pathophysiology of smoke inhalation injury led to pharmacologic interventions and improvements in ventilatory strategies. One of the most successful ventilatory strategies was the **Volume Diffusive Respirator (VDR)**, a percussive ventilator that superimposes an oscillatory waveform on top of a pressure-cycled pressure control mode. This was the original “low-volume” ventilator. The VDR and other innovations have significantly reduced the mortality associated with inhalation injury.<sup>1</sup> The knowledge that burn patients often have metabolic rates 140-160% of their basal metabolic requirements led to aggressive nutritional support strategies to protect the patient’s protein stores and lean body mass.

Further improvements in care are evolving, ranging from better outpatient wound dressings to artificial skin. While burn creams are critical for the care of larger burns, they have their drawbacks when used for smaller burns (5-10%) that can be managed as an outpatient. These creams require 1-2 times a day dressing changes, which can be painful and anxiety provoking, especially to children. New silver-containing dressings are available that, with a

good initial cleaning in the burn clinic or emergency room, can be placed on the burn wound and left on until the wound is healed 7-10 days later. The creation of a true artificial skin has been on the mind of burn practitioners for decades, for the most challenging patients are those with large burns of 50-70% TBSA who have limited donor sites. Larger burns often require reharvesting of donor skin areas 4,5,6,7 times before closure of the skin can be attained. Since the donor skin can take between 7-14 days to heal, this delays reharvesting of these sites and therefore delays the definitive closure of the burn wound. Early experience with cultured autologous skin, really just a cultured bilayer of epithelium, showed good early engraftment but almost no durability or long-term skin coverage.<sup>2</sup> Dermal templates, such as human processed alldermis and manufactured dermis, have some success and application, but are cumbersome to use and prone to infection.<sup>3</sup> This limits their applicability in the patients who need an “artificial skin” the most – patients with large TBSA burns. There has been some success with co-cultured auto-epidermis and auto-dermis that appears to have solved the problem of durability.<sup>4</sup> This true “artificial skin” may soon be available.

## BURN CENTER CARE IS MULTIDISCIPLINARY

Key to the success of burn centers and the improvements in the LD50 has been the concept that the care for the patient is multi-disciplinary. Since its inception in 1967 the American Burn Association, the premier society for the advancement of burn care, has involved doctors, nurses, nutritionists, respiratory therapists, psychosocial specialists, and rehabilitative therapists. This collaboration has resulted in a highly developed team. Their skills have made burn centers ideal areas to treat other challenging skin disorders. Exfoliative disorders such as Stevens-Johnson’s Syndrome / Toxic Epidermal Necrolysis, Pemphigus Vulgaris, Staphylococcal Scalded Skin Syndrome can be cared for in a burn center where climate controlled rooms, expertise in wound care, and effective pain control

practices are available.<sup>5</sup> Massive soft tissue injury from trauma or necrotizing fasciitis can also be managed well in a burn center.

## REHABILITATIVE PHASE OF BURN INJURY

The recovery from burn injury has both an acute phase and a chronic phase. The acute phase, addressed above, should generally last 1 day of hospitalization for each percentage of the body surface burned, i.e. a 50% TBSA burn should spend about 50 days in the burn center. It is important for the patients to realize that this burn center stay is only the first part of their recovery. Once the burn wounds are definitively closed the areas of spontaneously healed skin and the areas of grafted skin will continue to remodel for up to 1-3 years. This remodeling of scar is a process where the body shrinks the scar. Over areas of important function – flexor surfaces, around joints – and around important cosmetic areas – face and hands – this shrinking and remodeling can result in highly disfiguring scar. Interventions to minimize this contraction are meticulous care of the skin (avoidance of harsh soaps, use of moisturizing creams and avoidance of the sun for 12-18 months), scar massage, rehabilitation with active and passive range of motion, compression of the burn scar with compressive custom made garments, and silicon sheeting. Many of these therapies are painful for they involve stretching dense hypertrophic burn scar. During this period pain management with the use of narcotics is vital. Many times these measures are only partially successful and reconstructive surgery is necessary.

Though aggressive attempts at nutritional support during the acute phase of burn care is felt to have been instrumental in improving outcomes for thermally injured patients over the last 20 years, patients with significant burn still lose 10-20% of their lean body mass during their hospitalization. This loss of lean body mass makes their rehabilitation more difficult and delays patients' return to full function. The use of anabolic agents and more aggressive exercise regimens may be able to reverse some of these deficiencies.<sup>6</sup>

## PREVENTION

The skin has multiple functions: regulation of heat exchange; prevention of fluid loss; barrier to infection and mechanical trauma; and aesthetics. Since we cannot restore skin to its original state after injury, the best treatment of injury is prevention. Efforts at prevention have made both the work place and the home environments safer (smoke detectors, fire codes, sprinkler installation, safer appliances and heaters) and overall reduction in burn injury has indirectly proven the impact of these efforts. For males the incidence of burn and fire injury for every 100,000 population dropped from 601 in 1985 to 192 in 1991 and females dropped from 647 to 158 during the same period.<sup>7</sup>

Further efforts are necessary. Reducing home and apartment hot water heaters to 120°F / 49°C would reduce scald injuries to children and the elderly. Careless smoking habits, especially mixed with use of alcohol, are a significant source of preventable fire etiology. Better education of the public of the dangers of kerosene and gasoline, which should not be used for cleaning or clearing brush, would reduce flame injuries. The proliferation of outdoor cooking and fire pits has increased injuries from these sources. Making homes safer to prevent slipping and falls while carrying hot liquids would reduce injuries in the aged. Elderly cooking accidents, especially in people with reduced hearing, eyesight, or ability to flee a fire, are an all too common preventable etiology of burns. Screening all burn victims for signs of domestic violence would help these patients by reducing the likelihood that they would return to an unsafe home environment and the potential for further injury.

## CONCLUSION

There have been continued and steady improvements in both prevention of burns and the care of the thermally injured patient. It is a testament to generations of hard work by multidisciplinary teams dedicated to the care of these challenging patients. Future improvements are just around the corner.

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## Disclosure of Financial Interests

The author has no financial interests to disclose.

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