A 27-year-old male suffers superficial partial-thickness to deep partial-thickness burns to his torso and upper extremities (all circumferential), both hands, face, and neck following an automobile explosion (Figure 1 see A2). Total body surface area (TBSA) burned is 48 percent. He sustains no additional trauma except for a suspected inhalation injury associated with facial burns. He is intubated at the hospital nearest to the scene of the accident and transferred to the Richard M. Fairbanks Burn Center at Wishard Memorial Hospital for multidisciplinary management.

Overview of Burn Management

Last year in the United States, an estimated 450,000 people received treatment for burn injuries.1 Approximately 10 percent were hospitalized, with more than half of these individuals treated at one of the nation’s 125 dedicated burn units.

“The care a patient receives within the first critical hours following a burn injury significantly impacts outcome,” emphasizes Rajiv Sood, MD, professor of plastic and reconstructive surgery at the Indiana University School of Medicine. “Individuals who have experienced major burns should be treated as trauma victims, since their burns often occur in conjunction with a
The patient is admitted, and a triple-lumen central venous line and Foley catheter are placed for fluid resuscitation and urine output monitoring. Fluid resuscitation is initiated per the Parkland formula. Fluid requirements for the 24-hour resuscitative phase are calculated to be 15,369 mL, but eight additional liters are needed owing to the patient’s inhalation injury. Half of the total fluid requirement is administered during the first eight hours, with the remaining half given over the next 16 hours. Fluids are titrated to the patient’s urine output, with a target output of 0.3 to 0.5 mL/kg/hour.

Escharotomy is performed on both arms (Figure 1), and the wounds are dressed with a collagenase ointment (to provide enzymatic debridement) combined with a polysporin ointment (for antimicrobial coverage).

Fluid Resuscitation, Escharotomy, and Topical Antimicrobials

Burns exceeding 20 percent TBSA are associated with increased capillary permeability and intravascular volume deficits that are most severe during the first 24 hours after injury. The goal of fluid resuscitation is to provide the minimal amount of fluid necessary to support organ perfusion. Inadequate resuscitation leads to decreased perfusion, acute renal failure, and death, whereas over-resuscitation can result in cerebral and pulmonary edema. Many resuscitation formulas have been described, but the Parkland formula, developed in the 1960s, remains the most commonly used.

In patients with circumferential deep-partial to full-thickness burns, the combination of burn-induced changes in capillary permeability together with the infusion of large volumes of crystalloid solutions during resuscitation causes edema beneath the inelastic eschar that constricts underlying tissues. Escharotomy, often performed at the bedside, is undertaken to reduce elevated tissue pressure and prevent secondary ischemic necrosis. The incision is carried down completely through the eschar and extended across any involved joints. Care is taken to avoid penetrating the underlying subcutaneous tissue and damaging nerves and blood vessels.

Topical antimicrobial therapy controls bacterial colonization, avoids progression to invasive infection, and allows healing of the burn wound. Commonly used topical antibiotics are silver sulfadiazine, mafenide acetate, polymyxin B sulfate and bacitracin zinc ointment, acetic acid solution, and topical silver dressings.
At 24 hours post-burn, the patient continues to receive analgesic and sedative drips and maintenance fluids. Urine output, central venous pressure, and blood pressure are continually monitored. On post-burn day 5, the patient is taken to the burn unit operating room. All wounds are tangentially excised to healthy tissue, temporarily covered with a homograft (Figure 4), and dressed with a silver-based antimicrobial agent and sterile gauze.

Early Excision and Grafting

Before 1980, grafting was postponed until the burn eschar had spontaneously separated from the wound. That approach resulted in high mortality rates for patients with large burns, prompting surgeons to advocate for early intervention. Tangential excision involves removing nonviable tissue, the major source of wound infection and colonization, leaving behind functioning tissue to serve as a bed for a skin graft. Temporary or permanent grafting is performed immediately after excision to re-establish the skin barrier and mitigate the immunosuppression and muscle catabolism associated with acute burns.

“The surgical technique of early excision and grafting has revolutionized the care of severe burns, lowering both morbidity and mortality, reducing hospital stays, and achieving better functional and cosmetic outcomes,” Dr. Sood reports.

A variety of biologic wound dressings (i.e., allografts) and biosynthetic products are used as skin substitutes in burn patients. Human allograft (homograft) harvested from organ donors is considered the gold standard dressing. It consists of an epidermal component that provides a barrier (until rejected by the patient in three to four weeks), and a dermis component that revascularizes and incorporates.

On post-burn day 10, the patient returns to the operating room for autografting. All homograft is adhered to the wound bed. His level of prealbumin, a hepatic protein that is a marker for nutritional status, is normal at 15. All wounds are debrided using a hydrosurgery system. Donor skin is obtained from the bilateral lower extremities and meshed in a 2:1 ratio. Hemostasis is achieved using epinephrine-soaked laparotomy sponges, thrombin spray, and electrocautery. Split-thickness skin grafts are affixed to the debrided wound using Artiss® fibrin sealant without the use of staples or sutures (Figure 5). Skin grafts to the torso are covered with a non-adhesive hydrocellular polyurethane dressing; grafts to the face, neck, arms, and hands are dressed with bacitracin-impregnated conformant sterile gauze.

Autograft Harvesting and Hemostasis

Autografts are generally divided into two general types: sheet grafts and mesh grafts. A sheet graft is skin taken as is from a donor site, placed on an excised wound, and secured. Mesh grafts are used in patients with large TBSA burns when there is inadequate normal skin to provide extensive sheet grafts.

“Available skin can be meshed and expanded in a variety of ways to cover much larger surface areas than the original sheet,” explains Dr. Sood. “The drawbacks to mesh grafts are increased scarring and contraction as compared with sheet grafts and a permanent grid pattern on the grafted skin.”

Hemorrhage control is of paramount importance during tangential excision and grafting, as blood loss from the burn wounds and skin donor sites can be extensive. The average adult patient with a 25 percent TBSA burn can be expected to lose about 2200 mL (4.5 units) of blood during tangential excision and up to another half unit from the donor sites—in other words, half his total blood volume. Epinephrine provides some hemostasis by capillary contraction, and the addition of thrombin enhances coagulation by facilitating activation of the clotting cascade.

Securing the Autograft

“Two factors determine the success of autografting: apposition of the graft to the recipient site and its subsequent immobilization on the wound,” points out Dr. Sood. “The current standard of care is to use staples or sutures for graft fixation. However, a fibrin sealant containing a lower amount of thrombin than standard sealants has been shown to be at least as effective as standard treatment and has the added advantage of avoiding suture/staple scars and the pain of staple removal.” Additionally, fibrin sealant use is associated with a lower incidence of hematoma/seroma formation, enhanced engraftment and wound closure, and early mobilization to permit physical and occupational therapy.”
The dressings are removed one day after surgery to evaluate the allografts. Passive range-of-motion (ROM) exercise of the hands and arms is initiated on postoperative day 1 by an occupational therapist. The patient remains intubated.

On post-burn day 22, the patient is extubated, and on day 23, the central line and Foley catheter are removed. On post-burn day 30 (Figure 6), the patient is discharged to an acute rehabilitation facility, where he remains for 10 days before beginning outpatient therapy. Seven weeks post-burn, he begins wearing a custom-made pressure garment. Three months after his injury, he has no physical limitations or deficits in active ROM and is able to return to work. He is seen at follow-up six months after his injury (Figure 7), and is discharged from care another six months later. He no longer needs to wear a pressure garment.

Before hospitalized burn patients transition to outpatient care, they must be able to maintain adequate wound care, pain control, and nutrition. Scar management often continues long after healing has occurred.

“Pressure garments help to decrease hypertrophic scarring, and scar massage with a moisturizing cream may provide a more cosmetic outcome” Dr. Sood concludes.

### References


