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Management of acute-phase burn patients in emergency department

Chiara Busti,[1] Roberto Marchetti,[2] Manuel Monti[1]

[1]Emergency Department, AUSL UMBRIA1 Ospedale di Gubbio, Gualdo Tadino (PG); [2]Villa Maraini Foundation, Rome, Italy

ABSTRACT

In this review, we discuss the management of burn patients in the emergency room. Burn injury is characterized by a hypermetabolic response with physiological, catabolic and immune effects. The treatment of burns requires a multidisciplinary approach and a proper management able to reduce both the damage and the risk of infections. The management of a burn patient begins with a primary evaluation: i) maintaining a high index of suspicion for the presence of airway compromise following smoke inhalation and secondary to burn edema; ii) identifying and managing associated mechanical injuries; maintaining hemodynamic normality with volume resuscitation; iii) controlling temperature; iv) removing the patient from the injurious environment. Secondary evaluation holds fundamental importance and is carried out through the head-to-foot objective examination and diagnostic investigations as well as the wound dressing. Clinicians also must take measures to prevent and treat the potential complications of specific burn injuries (*e.g.*, compartment syndromes). The role of this article is to highlight some quick and effective guidelines for the management of burn patients in the early stages, within the emergency room, before the transfer to the burn unit.

Correspondence: Manuel Monti, Emergency Department, AUSL UMBRIA1 Ospedale di Gubbio, Gualdo Tadino (PG), Italy.
E-mail: manuel.monti@uslumbria1.it

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Introduction

The term "burn" indicates a traumatic injury to the epithelial tissue caused by thermal, chemical or electrical agents. In some cases, the degeneration also affects underlying tissues and can involve both muscles and bones.[1] In addition to cytokines and other inflammatory mediators at the injury site, stress hormones, such as catecholamine and cortisone, are released from the adrenal glands and cause systemic effects.[2] Burns usually cause distributive shock and an abnormal physiological state in which tissue perfusion and oxygen delivery are seriously compromised due to a marked leakage of intravascular fluid from the capillaries into the interstitial space. This contributes to the formation of profound tissue edema and accumulation of fluids even in the tissues that are not directly involved with the injury.[3] Burn injury also depresses cardiac function within the first 24/48 hours through oxidative stress and the release of mediators such as interleukin 6 and tumor necrosis factor.[4] Decreased cardiac function and associated hypovolemia, together with low blood flow caused by vasoconstriction, affect the tissue perfusion and organs (distributive shock), including lungs, liver and gastrointestinal tract, increasing tissue dysfunction and organ damage.[4]

In addition to hypovolemic and hypermetabolic reactions, burn damage has a profound effect on the immune system, and infection is the main complication that can worsen the prognosis of the severely burned patient. Indeed, the destruction of the skin barrier and the presence of necrotic tissues foster bacterial growth. The concomitant loss of the skin protective function and a state of generalized immunosuppression expose the patient to serious infections by viruses and pathogens. This bacterial contamination can even attack deeper organs, resulting in a serious case of septic shock. The main pathogens involved in the colonization of the lesion within the first 48 hours are gram +, while from the third to the twenty-first day the greatest risk comes from gram –, such as Pseudomonas and Klebsiella.[5]

In addition to determining the cause of a burn injury, it is imperative to classify the injury according to its severity, *i.e.*, its depth and size. For what concerns the depth, burns are classified into four degrees which are summarized in Figure 1.

Management of the burn patient in the emergency room

The burn patient is a traumatized patient who requires adequate care to improve the outcome. Management must be based on a multidisciplinary approach and must include a primary evaluation and a subsequent head-to-toe examination. The primary evaluation is performed using the algorithm present in the Advanced Life Support system (Figure 2).[6]

Evaluation of the airway is one of the first actions to be taken and the presence of signs of smoke inhalation or direct burns of the oral cavity are an indication for early intubation. It is also important to remember that the burn patient is also a trauma patient, and the stabilization of the cervical spine must also be assessed in the primary examination.[7]

During the breathing analysis, it is always necessary to re-assess the position of the laryngeal tube or possibly positioning it, if this was not done in the first phase; it is also fundamental to exclude lesions associated with the chest, also at the level of the patient's posterior wall, which can reduce the pulmonary excursion and it is possible to note any asymmetries of the thorax, swollen jugular veins, trachea not in the axis which may indicate the presence of a pneumothorax. Oxygen saturation, respiratory rate, and administration of oxygen therapy with reservoir should be measured.[8] During phase C (circulation), in addition to measuring vital parameters, it is essential to place large caliber venous accesses or, in case of difficulties, intraosseous access should be used, starting to infuse fluids. Appropriate fluid management represents the foundation of acute burns management. Without early and effective treatment, burns involving greater than 15 to 20% of total body surface area (TBSA) will result in hypovolaemic shock.[9] Mortality is increased if resuscitation is delayed longer than 2 hours post-burn injury.[9]

Secondary evaluation

The secondary evaluation is carried out when the patient is stable from the primary evaluation. It is a sequence of actions allowing a better evaluation of the patient and the damage caused by the trauma and intervention in the most appropriate way before going to the best hospital for his condition.[10] The secondary evaluation allows for obtaining a patient history (also by interviewing possible witnesses), collecting the dynamics of the event, and carrying out a complete head-to-toe examination of the victim. The dynamic is important to understand the combustion material causing but also any trauma potentially suffered by the patient.

During the medical history, various information will be collected using a mnemonic model called SAMPLE:

S = signs and symptoms
A = allergies (to drugs or other substances)
M = medicines (current therapies)
P = previous pathologies (remote and recent pathological history)
L = last lunch (last meal)
E = event (how the event occurred) or tests (performed by the patient)

The head-to-foot examination allows for assessing the presence of any traumatic injuries, also using point-of-care ultrasound, to evaluate the extent of the burns, and to remove clothes and other objects present on the patient's body (Figure 3). As already discussed before, the early start of fluid therapy holds a fundamental role. The quantity of crystalloids that must be administered to the patient is obtained using the Parkland formula (Figure 4).[11] If urine output is insufficient despite administration of a large volume of crystalloids, consultation with a burn unit is necessary because these patients have an

First-degree (superficial) burns
First-degree burns affect only the outer layer of skin, the epidermis. The burn site is red, painful, dry, and with no blisters. Mild sunburn is an example. Long-term tissue damage is rare and classification of burn depth consists of an increase or decrease in the skin color.
Second-degree (partial thickness) burns
Second-degree burns involve the epidermis and part of the lower layer of skin, the dermis. The burn site looks red, blistered, and may be swollen and painful.
Third-degree (full thickness) burns
Third-degree burns destroy the epidermis and dermis. They may go into the innermost layer of skin, the subcutaneous tissue. The burn site may look white or blackened and charred.
Fourth-degree burns
Fourth-degree burns go through both layers of the skin and underlying tissue as well as deeper tissue, possibly involving muscle and bone. There is no feeling in the area since the nerve endings are destroyed.

Figure 1. Classification of burn depth.[1]

increased risk of resuscitation complications, including compartment syndromes of the abdomen and extremities. Patients with inadequate diuresis despite the administration of large volumes of crystalloid may respond to a colloid infusion or other measures. In meta-analyses, albumin administration has been shown to decrease total fluid volumes by approximately half 72 hours after injury.[12] Although pain management represents a major challenge for clinicians, appropriate pain control is the foundation of effective burn care, from initial injury to long-term recovery. The same treatments designed to treat burn wounds can inflict more pain than the initial injury itself; it is therefore a clinician's responsibility to adopt a multimodal treatment approach to burn pain. Vigilant assessment of pain, a meaningful understanding of the pathophysiology, and pharmacological considerations at different stages of injuries contributing to pain will enhance the clinician's ability to provide effective pain management (Figure 5).[13] The wound should be then cleaned with soap and water, removing all debris. The water should be at room temperature or warmer to avoid hypothermia. Broken blisters are removed except for small ones on the palms, fingers, and soles. Unruptured blisters can sometimes be left intact but should be treated by the application of a topical antimicrobial. In patients who need to be transferred to a burn unit, dry dressings may be applied. Bulky blisters (>3 cm) or those located near the joint sites should be opened, sparing the roof.[14]

It is necessary to monitor the patient and perform blood chemistry tests, electrocardiogram, and blood gas analysis (essential to evaluate carboxyhemoglobin, a sign of carbon monoxide inhalation). Metabolic changes may include hypoalbuminemia, which is partly due to hemodilution (secondary to the use of replacement fluids) and partly due to protein loss into the extravascular space through damaged capillaries. Dilution-related electrolyte deficits may develop; they include hypomagnesemia, hypophosphatemia, and hypokalemia. Metabolic acidosis may result from shock. Rhabdomyolysis or hemolysis may result from deep thermal or electrical burns to the muscle or from muscle ischemia due to the constricting effect of the eschar. Rhabdomyolysis, causing myoglobinuria or hemolysis and then hemoglobinuria, can lead to acute tubular necrosis and acute kidney injury. Imaging diagnostics must include a chest x-ray in the red room and possible computed tomography if polytrauma has been found. Gastric decompression must be performed through the positioning of a nasogastric tube (>20% adult TBSA, >10% child TBSA) and the subsequent management of the lesions is to cool the patient with running water or physiological solution (NaCl 0.9%) to then cover it with dry cloths.

If the patient has chemical burns, any dust should be removed with brushes or brushes, irrigating him for a long time, for approximately 30 minutes to 1 hour.

Direct contact by the emergency doctor with the specialists of the major burn unit is fundamental, as well as the use of photographs, the transmission of vital parameters and the patient's response to early treatments carried out in the emergency room.

Airway

Maintain a patent airway

Assess for signs of inhalation injury

Stabilize the cervical spine

Breathing

Evaluate RR, SaO2 and effectiveness of respiratory excursions

Always deliver 100% O2, assist with bag and mask if necessary

Run IOT if indicated, collect history first

If ventilation difficult:

- Check the position of the tube/aspirate
- Exclude associated chest injuries/circumferential trunk burns

Circulation

Assess HR (normal 100-120 bpm) and blood pressure

Place 2 large caliber venous accesses or intraosseous access

Start infusion of crystalloids by switching to the Parkland formula as soon as the calculation is done:

- adult: RL 500 ml
- child: RL 250 ml

Figure 2. Primary evaluation of the burn patient.[6]

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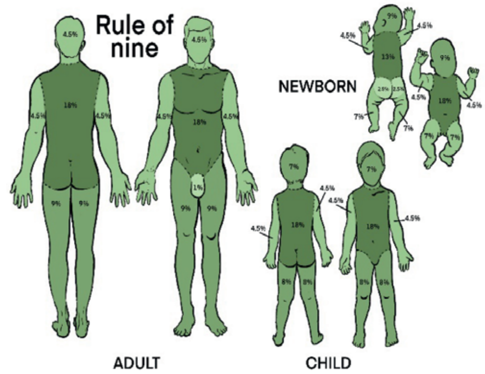

Area	< 1 y	1-4 y	5-9 y	10-14 y	Adult
Head	9.5	8.5	6.5	5.5	4.5
Neck	1	1	1	1	1
Trunk	13	13	13	13	13
Harm	2	2	2	2	2
Forearm	1.5	1.5	1.5	1.5	1.5
Hand	1.25	1.25	1.25	1.25	1.25
Tight	2.75	3.25	4	4.25	4.5
Leg	2.5	2.5	2.5	3	3.25
Foot	1.75	1.75	1.75	1.75	1.75
Gluteus	2	2.5	2.5	2.5	2.5
Genitalia	1	1	1	1	1

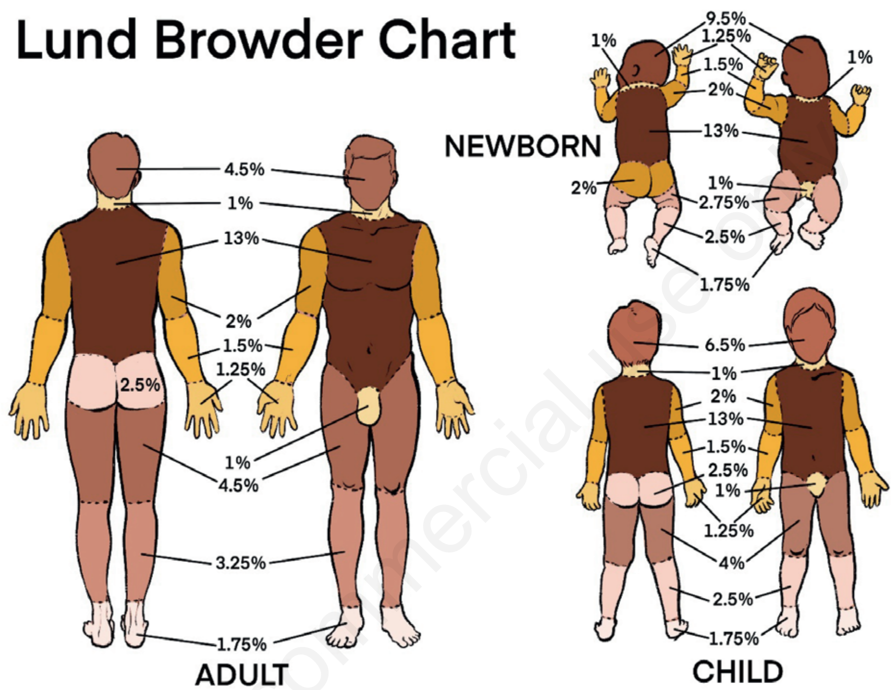

Figure 3. Lund Browder's rule or rule of 9 to evaluate the burn extension.

- ADULT: 2 ml RL x weight x % burn extension II–III degree - CHILD <30 Kg: 3 ml RL x weight x % burn extension II–III degree - ELECTRICAL BURNS: 4 ml RL x weight x % burn extension II–III degree
Infusion rate: half in the first 8 hours and half in the following 16 hours - Place bladder catheter - Assess urine output as a guide to fluid therapy: Target ADULT: 0,5 ml/kg/h Target CHILD <30 Kg: 1 ml/kg/h
Increase infusion rate by 1/3 if urinary output drops by 1/3 for 2 consecutive hours Reduce infusion rate by 1/3 if urinary output increases by 1/3 for 2 consecutive hours

Figure 4. Parkland formula for calculating the administration of crystalloids in the burn patient.[11]

Morfina IV in refracted boluses
2-5 mg every 5 min until titration
CHILD: 0,1 mg/Kg to be repeated every
3-5 minutes for a max 0.3 mg/kg

Figure 5. Analgesia in burn patients.[13]

Conclusions

There have been significant improvements in outcomes following burns in the second half of the 20th century, reflecting advances in critical care – in particular, following the introduction of fluid resuscitation protocols, early burn excision and closure, antimicrobials, and infection control, nutritional support, and modulation of the metabolic response. These improvements in care have led to the survival of most patients. A fundamental role in improving the outcome of severely burnt patients is in the management of the first hours in the emergency room.[15] The role of this review is to reiterate some fundamental concepts to be used in the case of the initial management of patients with severe burns within peripheral hospitals.

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