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Burn Resuscitation and Early Management

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ABSTRACT

Burns are the fourth most common type of trauma worldwide, after traffic injuries, falls, and interpersonal violence. This is a concise review of recent burn fluid management literature. Strategies to avoid over-resuscitation are discussed.

Advances in the care of burned patients have historically been related to the larger field of critical care, especially regarding infectious complications, nutritional supplementation, and metabolic manipulations. The unique resuscitation requirements of burn patients have recently been re-examined to minimize over-resuscitation and its associated complications, which can also be an issue in non-burned critically ill patients. However, burn patients often require multiple sequential operations. The loss of the normal skin barrier increases the risk of multiple infections, sepsis, and organ failure. This review will summarize some of the recent advances in burn care.

KEYWORDS: Burn, fluid management, resuscitation, burn care.

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INTRODUCTION

Burns that affect more than a third of the body surface will result in increased tissue permeability, leading to the loss of plasma and electrolytes that extravasate from the affected area. This, in turn, results in hemodynamic alterations that can eventually lead to hypovolemic shock[1].

During the initial resuscitation phase for burn patients, significant volumes of fluids are typically required to restore adequate perfusion pressure and prevent organ failure. To estimate the actual fluid requirements, Baxter and Shires introduced the Parkland formula in 1968, which significantly improved outcomes for burn patients[2]. The original formula suggests a resuscitation volume of between 3.5 mL and 4 mL per kilogram of body weight per percentage of total body surface area (TBSA) over 24 hours, with half of the fluid volume administered within the first 8 hours post-burn[3].

Proper initial care for patients with major burns is crucial for achieving positive clinical outcomes. Early identification and management of airway and breathing problems are vital in preventing early fatalities. Implementing appropriate fluid resuscitation protocols is essential in avoiding major complications. Recognizing and treating associated injuries is also of paramount importance.

The prehospital care of burn patients necessitates a thorough evaluation of the airway, particularly when smoke inhalation is suspected. Clinical findings, such as carbonaceous sputum, hypoxia, deep facial burns, or a hoarse voice (but not singed nasal hairs), should prompt early endotracheal intubation. Burn surgeons have debated whether less severe signs should also warrant immediate intubation. The most common reasons for early intubation were reported as 'airway swelling' (34.1%), 'prophylaxis' (27.9%), and 'ventilation or oxygenation needs' (13.2%)[4]. While consensus criteria for intubating patients with suspected inhalation injuries are still lacking, it is highly recommended to initiate early consultation with the burn surgeon at the receiving hospital[5].

ESTIMATING INITIAL FLUID REQUIREMENTS

Perhaps the most distinctive aspect of burn care is the necessity for acute burn resuscitation. The systemic inflammation experienced during the immediate post-burn period differs physiologically from that in traumatic injuries or sepsis. Extensive research has been dedicated to refining resuscitation strategies to minimize complications, such as respiratory failure or abdominal compartment syndrome[6].

Assess circulation by monitoring blood pressure, pulse rate, and the color of unburned skin. Employ a continuous cardiac monitor and pulse oximeter on an unburned extremity or the ear for ongoing monitoring. Heart rates above this level may indicate hypovolemia resulting from associated trauma,

inadequate oxygenation, unrelieved pain, or anxiety[7]. Abnormal cardiac rhythms can result from electrical injuries, underlying cardiac issues, or electrolyte imbalances.

Insert a large bore intravenous catheter. For burns greater than 20%, it is advisable to have two large bore, indwelling venous catheters, particularly during transport. In the pre-hospital and early hospital settings, before calculating the Total Body Surface Area (TBSA) burned, initial fluid rates for patients with visibly extensive burns are based on patient age:

- 5 years old and younger: 125 ml of Lactated Ringers (LR) per hour.
- 6-13 years old: 250 ml of LR per hour.
- 14 years and older: 500 ml of LR per hour.

The definitive calculation of hourly fluid rates occurs during the secondary survey. The most commonly used guide for estimating second and deeper degrees of burns is the 'Rule of Nines.' In adults, distinct anatomic regions each represent approximately 9% of the Total Body Surface Area (TBSA). However, in infants or children, the 'Rule' deviates due to the relatively larger surface area of a child's head and the smaller surface area of the lower extremities[8]. **FIGURE 1**. First degree (superficial burn without blister formation) areas are not included in the TBSA burn calculation.

When only a portion of an anatomical area is burned, calculate the percentage of TBSA burned based on the extent of injury to that specific site, rather than the entire area.

The size of a patient's hand, including the fingers, represents roughly one percent of their total body surface area. Therefore, using the patient's hand size as a reference, you can estimate the extent of irregularly scattered burns[9]. **FIGURE 2.**

Fluid Resuscitation

The adjusted fluid rates are calculated according to the **TABLE 1.**

The patient's urinary output and physiological response should guide further fluid titration. It's more effective to increase fluids based on the patient's response rather than attempting to remove excess fluids once they've been administered.

Certain patients, such as those with a delayed initiation of fluid resuscitation, prior dehydration, chronic or acute alcohol use or abuse, injuries from methamphetamine labs, high-voltage electrical injuries, or inhalation injuries, may require more fluids than initially estimated. Again, adjustments to fluid rates are determined by the patient's response.

While hypovolemia was initially the leading cause of mortality in burn shock and still increases the risk of acute kidney injury, formula-based fluid resuscitation, in some cases, led to hypervolemia, resulting in adverse effects and increased mortality.

In addition to the improvement in pulmonary function due to reduced lung edema, abdominal compartment syndrome (ACS) stands as one of the most devastating complications, with a mortality rate exceeding 80% in burn patients[10].

MONITORING FLUID STATUS

The most widely used parameters for assessment include urinary output and vital signs, such as blood pressure or mean arterial blood pressure (MAP) and heart rate, since they can be measured with minimal effort and are applicable in most circumstances and locations worldwide. Notably, Baxter and Shires used urine output (UO) as the target parameter in their formula-based resuscitation of burn patients. Over the years, urine output has continued to serve as the primary parameter for goal-directed resuscitation.

Patients with extensive burns, with or without associated smoke inhalation, are at risk for developing acute respiratory distress syndrome (ARDS) and may require prolonged mechanical ventilation. High-frequency percussive ventilation (HFPV) has been employed both to prevent the development of ARDS and to support patients who develop ARDS following burns and smoke inhalation.

The management of hyperglycemia in the burn intensive care unit (ICU) is a topic frequently under discussion, with concerns that overly aggressive glucose control might lead to hypoglycemic events and increase adverse outcomes..

REFERRAL CRITERIA

Burn injuries that should be referred to a Burn Center include the following[11]:

1. Partial thickness burns exceeding 10% of the total body surface area (TBSA).
2. Burns involving the face, hands, feet, genitalia, perineum, or major joints.
3. Third-degree (full-thickness) burns in any age group.
4. Electrical burns, including lightning injuries.
5. Chemical burns.
6. Inhalation injuries.
7. Burn injuries in patients with preexisting medical conditions that may complicate management, extend recovery, or impact mortality.
8. Patients with burns and concomitant trauma (such as fractures), in which the burn injury poses the greatest risk of morbidity or mortality. In such cases, if the trauma presents the greater immediate risk, the patient may initially be stabilized in a trauma center before being transferred to a Burn Center. Physician judgment will be necessary in such situations and should align with the regional medical control plan and triage protocols.
9. Burned children in hospitals lacking qualified personnel or equipment for pediatric care.
10. Burn injury in patients who will require special social, emotional or rehabilitative intervention.

CONCLUSION

Any burn, regardless of its size, can be a serious injury. Healthcare providers must possess the ability to rapidly assess these injuries and formulate a priority-based care plan rooted in both primary and secondary survey elements. The specifics of the care plan are dictated by the type, extent, and

depth of the burn, in conjunction with the available resources. It is essential for every healthcare provider to be knowledgeable about how and when to contact the nearest specialized burn care facility or Burn Center.

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TABLE 1.

Category	**Age and weight**	**Adjusted fluid rate**
Flame or scald	Adults and older children (>14 years old).	2 ml LR x kg % TBSA.
Flame or scald	Children (<14 years old).	3 ml LR x kg % TBSA.
Flame or scald	Infants and young children (<30 kg).	3 ml LR x kg % TBSA Plus D5LR at maintenance rate.
Electrical injury	All ages.	4 ml LR x kg % TBSA Plus D5LR at maintenance rate for infants and young children.

FIGURE 1. "RULE OF NINES" IN ADULTS AND CHILDREN.

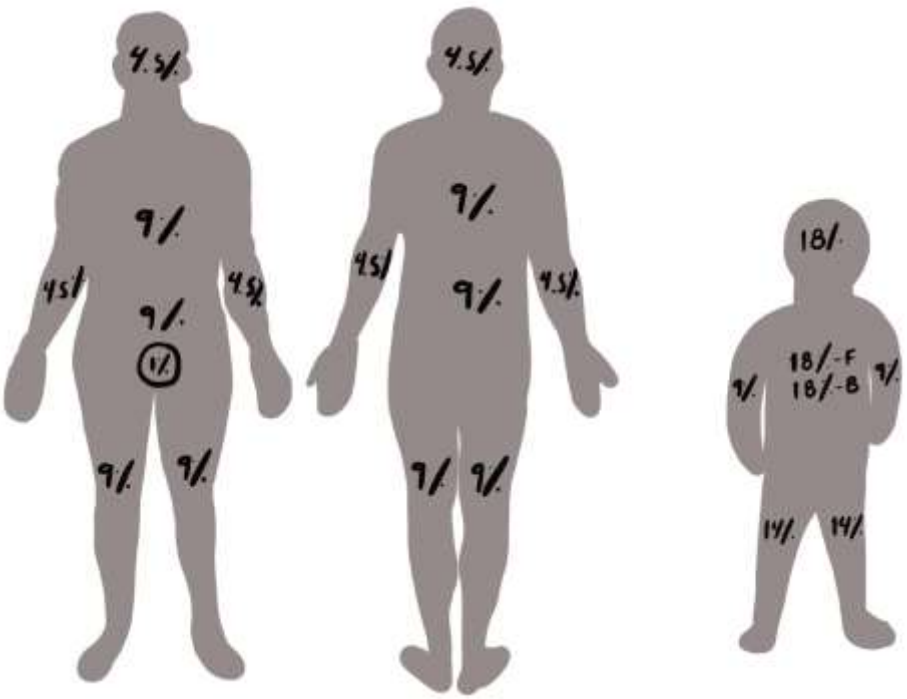

FIGURE 2. PATIENT'S HAND.