Chapter 107
Approach to Burn Patients in the ICU

107.1 Introduction

Burn injuries are critical conditions requiring prompt and organized management due to their potential for systemic complications, including airway compromise, shock, infections, and long-term physical and psychological effects. Patients with significant burns, especially those involving inhalational injury or large total body surface area (TBSA) burns, require intensive care. Early interventions, both prehospital and within the ICU, are essential to improve outcomes [1, 2] [Ref: Algorithm 107.1].

107.2 Prehospital and Initial Management

Effective management of burn patients begins at the scene of injury.

First Aid

- Cooling the Burn Area: Immediate cooling of the burn area with tepid water (20–30 minutes) significantly reduces burn depth and progression. Avoid using ice-cold water or ice, as they can exacerbate tissue damage.
- Subatmospheric Pressure Dressings: The use of subatmospheric pressure dressings, such as vacuum-assisted closure (VAC) therapy, can minimize edema and improve outcomes in certain burn areas.

  Initial Evaluation

  The immediate priorities upon arrival align with the principles of Advanced Trauma Life Support (ATLS):
- Airway Assessment: Assess for signs of inhalational injury, such as soot in the airway, carbonaceous sputum, or stridor. Early intubation is critical if airway edema or inhalation injury is suspected.

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- Breathing: Exclude complications like pneumothorax or chest wall burns that could restrict respiration. Assess oxygenation and ventilation through clinical examination and arterial blood gases.
- Circulation: Establish vascular access with two large-bore IV cannulas or a central line if peripheral access is inadequate. This step ensures fluid resuscitation can begin promptly [3].

107.3 Resuscitation Strategies

Fluid resuscitation is paramount in managing burn shock.

Fluid Calculation

- Modified Brooke's formula: American Burn Association 2018 guidelines advocate 2 mL of Ringer's lactate (RL) per kg body weight times the % of TBSA for flame and scald injury, whereas 4 mL of RL per kg body weight times the % of TBSA for electric burn. The latest consensus recommends starting at lower fluid resuscitation rate (2 mL x weight x %TBSA) and then titrating and going higher as per response of individual patient (target urine output of 0.5 mL/kg/h minimum) [4].
- Colloid may be added in the first 24 hours to achieve target end points and thus reduce the need of high volume of crystalloid administration and leading to complications like "fluid creep" [4].
- Parkland Formula: Traditionally used for initial fluid estimation (4x %TBSA x body weight in kg).
- Half of this volume is given in the first 8 hours from the time of burn, and the remainder over the next 16 hours.

Limitations and Individualization

- Limitations of the Parkland Formula: Overreliance can lead to "fluid creep" and complications like abdominal compartment syndrome. Individualized fluid titration based on hemodynamic monitoring and laboratory markers is essential.
- Alternate Resuscitation Strategies:
- Permissive Hypovolemia: In select cases, accepting lower blood pressure to minimize fluid overload. The fluid resuscitation volume should rather target an output of 0.5 mL/kg body weight per hour 30–50 mL/h.
- Colloids: The use of colloids like human albumin after the first 24 hours can help maintain oncotic pressure and reduce total fluid volume [5].

Monitoring

- Urine Output: Aim for 0.5–1 mL/kg/h (30–50 mL/kg) as a marker of adequate perfusion and 75–100 mL/h until urine clears in case of pigment in urine.
- Hemodynamic Parameters: Monitor blood pressure, heart rate, central venous pressure, and lactate levels.

- Crystalloids: Use lactated Ringer's solution initially. Avoid over-resuscitation to prevent complications like pulmonary edema.

107.4 Secondary Evaluation

After stabilization, a detailed secondary evaluation is essential.

- Head-to-Toe Survey: Assess for associated injuries (e.g., fractures, trauma).
- Burn Estimation: Accurately determine the TBSA using tools like the Rule of Nines or Lund-Browder chart.
- Adjust the fluid administration based on targets rather than a definite pre-calculated volume. Use of Human Albumin early if targets are not achieved with adequate fluid resuscitation or there is a risk of fluid overload.
- Send laboratory tests, chest X-ray
- Pain and anxiety management
- Psychological support
- Wound care (Fig. 107.1)

- History (AMPLET):
- A: Allergies
- M: Medications
- P: Past medical history
- L: Last meal
- E: Events leading to the injury
- T: Tetanus history (if **Unknown or < 3 doses of tetanus toxoid:** Administer Tdap, Td, or DTaP and Tetanus Immune Globulin (TIG). **≥3 doses of tetanus toxoid:** Administer Tdap, Td, or DTaP if it has been more than 5 years since the last dose. TIG is not required.

Fig. 107.1 Wallace's Rule of 9 for calculating % TBSA (Total body surface area)

```
     (Head) 9%
        |
        |
(Arm) 9%     9% (Arm)
   \        /
    \      /
     \    /
 18% (Anterior Trunk)
      |    |
      |    |
18% (Leg)     (Leg) 18%
      \    /
       \  /
        \/
   1% Perineum
```

107.5 Inhalation Injury Management

Inhalation injuries significantly increase morbidity and mortality.

- Oxygenation: Administer 100% oxygen to displace carbon monoxide.
- Diagnosis: Bronchoscopy is the gold standard.
- Nebulized Medications: Use nebulized heparin and N-acetylcysteine to reduce airway obstruction.
- Ventilation: Apply lung-protective strategies for patients with ARDS [6].

107.6 Pain and Sedation Management

Effective pain control is essential.

- Analgesia: Utilize multimodal approaches, including opioids and regional nerve blocks.
- Sedation: Adjust sedation levels to balance pain control with the need for patient interaction.

107.7 Nutritional Support

Burn patients experience a profound hypermetabolic response.

- Early Enteral Feeding: Initiate within 4–6 hours to mitigate hypermetabolism and support wound healing.
- Caloric Needs: Calculate based on predictive equations considering the burn size.
- Protein Requirement: 1.5–2 g of protein/kg/d
- Antioxidant vitamins (including vitamins E and C [ascorbic acid]) and trace minerals (including selenium, zinc, and copper) may improve patient outcome.
- Pharmacological Interventions:
- Beta-Blockers: Reduce hypermetabolic response (e.g., propranolol).

107.8 Infection Control

Burn wounds are highly susceptible to infection.

- Topical Antibiotics: Apply agents like silver sulfadiazine for full thickness burns and bacitracin for partial thickness burns.
- Systemic Antibiotics: Use only when there is evidence of infection to prevent resistance.
- Aseptic Techniques: Maintain strict asepsis during wound care [7].

107.9 Wound Care

Burn depth can be classified into partial (some, but not all layers of the skin are injured) or full thickness (all layers of the skin are injured).

Partial thickness can be first or second degree. A first-degree burn is a superficial injury limited to the epidermis and is characterized by redness, hypersensitivity, pain, and no skin sloughing. Whereas, second-degree burns involve the epidermis and part of the dermis. The skin may be red and blistered, wet, weepy, or whiter, yet edematous.

Full thickness burn is also called a third-degree burn in which there is destruction of the entire thickness of dermis and epidermis, including dermal appendages. This gives rise to the eschar formation.

Fourth-degree burns penetrate below the skin into the subdermal fat and are classified as fourth-degree burns. These burns also have an eschar on the surface.

Burn wounds have a zone of coagulation (central—maximum contact with source), zone of stasis, and zone of hyperemia (most peripheral).

- Clean the wound with soap or chlorhexidine and remove dirt and debris from wound.
- Limit exposed areas while dressing.
- Gently debride blisters >2 cms. Apply topical antimicrobial.

107.10 Advanced Surgical Interventions

Early surgical intervention can improve outcomes.

- Early Excision and Grafting: Perform within 48 hours to decrease the risk of sepsis and promote healing.
- Escharotomy/Fasciotomy: Indicated for circumferential burns causing compartment syndrome.

107.11 Monitoring and Prognostication

Effective monitoring aids in predicting outcomes.

- Scoring Systems:
- Revised Baux Score: Age + TBSA (%) + 17 (if inhalation injury present) to predict mortality.
- Abbreviated Burn Severity Index (ABSI): Considers age, gender, inhalation injury, depth, and TBSA. Ranges from 2 to 18 points, with a probability of survival ranging from $\geq 99\%$ to $\leq 10\%$.
- Frailty Assessment:

- Rockwood Scale: Assesses frailty in older patients to refine prognostication.
- Belgian Outcome in Burn Injury (BOBI) Score: Uses absolute values of age and BSA(%).

107.12 Special Considerations

Chemical Burns

- Decontamination: Remove contaminated clothing and irrigate the area extensively.
- Neutralizing Agents: Use specific agents when appropriate (e.g., calcium gluconate for hydrofluoric acid burns).
  Electrical Burns
- Cardiac Monitoring: Monitor for arrhythmias due to potential myocardial injury.
- Internal Injuries: Assess for deep tissue damage not apparent on the skin.
  Radiation Burns
- Management: Similar to thermal burns but consider systemic radiation effects.
- Long-Term Monitoring: For potential radiation-induced complications [8].
  Coagulopathy
- Risk Assessment: Severe burns can lead to coagulopathy due to massive tissue destruction.
- Management: Monitor coagulation profiles; administer blood products as needed.

107.13 Psychological and Social Aspects

Long-term recovery extends beyond physical healing.

- Rehabilitation: Early physical therapy to prevent contractures and maintain function.
- Psychological Support: Address issues like PTSD, depression, and anxiety with counseling and support groups.
- Social Integration: Assist with vocational rehabilitation and community reintegration.

107.14 Technological Advances

Incorporate new technologies for improved care.

- Point-of-Care Ultrasound (POCUS): Use for dynamic resuscitation monitoring, assessing cardiac function, and detecting complications like pneumothorax.

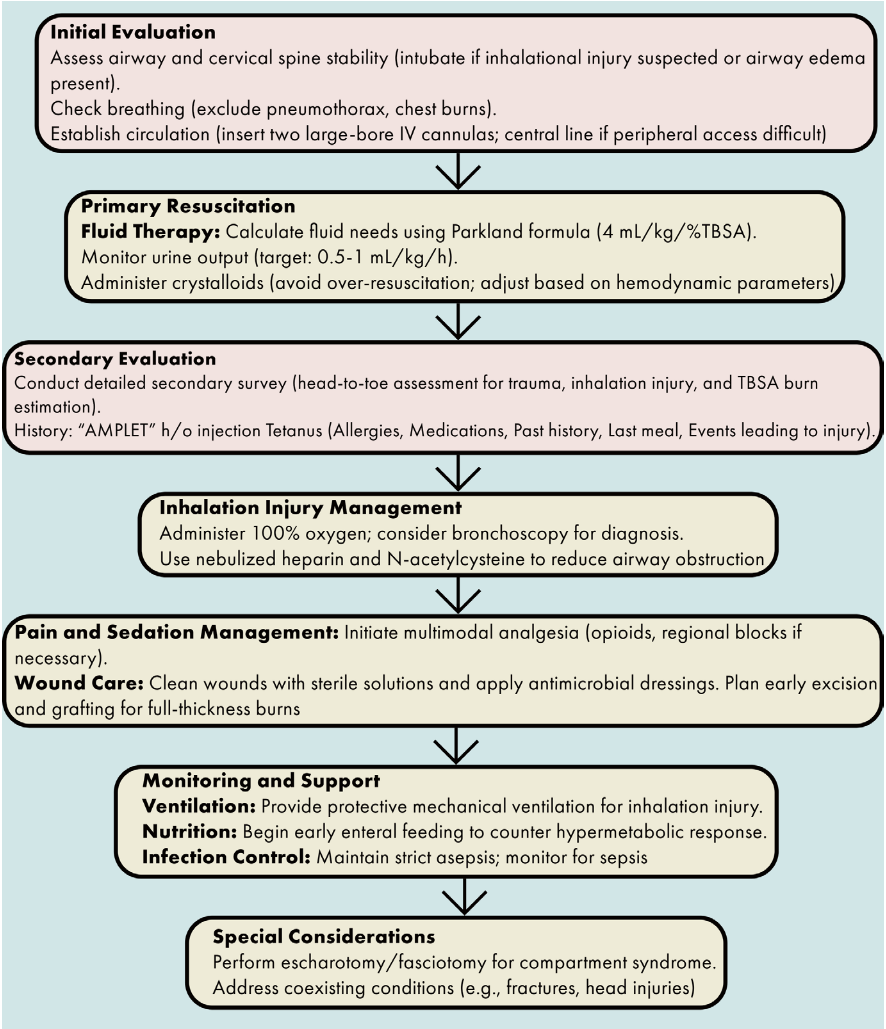
107.15 Research and Emerging Therapies

- Hemofiltration: Potential for removing inflammatory mediators; current evidence is emerging.
- Stem Cell Therapy: Investigational use for enhancing wound healing.
- Artificial Skin Substitutes: Development of bioengineered tissues for grafting.

107.16 Conclusion

Managing burn patients in the ICU requires a structured, multidisciplinary approach, beginning with prehospital care and extending through resuscitation, surgical intervention, and long-term rehabilitation. Incorporating individualized resuscitation strategies, aggressive nutritional support, advanced surgical techniques, and psychological care can significantly improve patient outcomes. Utilizing scoring systems and technological advances aids in monitoring and prognostication, ensuring evidence-based, patient-centered care.

Algorithm 107.1: Approach to burn patients in the ICU



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