Caring for a patient with severe burn injuries offers many challenges for critical care nurses. This article reviews various types of burns and what you need to know to provide initial resuscitative care for a patient if treatment in a designated burn center facility or burn ICU isn’t possible.

Although burn incidence has decreased slightly over the years, burn injuries still occur too frequently, with an estimated 3,500 fire and burn deaths each year (this figure includes deaths from smoke inhalation and poisoning). In addition, about 45,000 patients who sustain burn injuries require medical treatment or hospitalization yearly. According to the American Burn Association (ABA), hospital admission based on the type of burn include: 44% due to fire or burn injury, 33% due to scald injury, 9% due to contact burn injuries, 4% due to electrical burns, 3% due to chemical burns, and 7% due to miscellaneous causes of burns. Burn injuries are one of the most expensive catastrophic injuries to treat. For instance, a burn injury of 30% of total body surface area (TBSA) can cost as much as $200,000 in initial hospitalization costs; furthermore, for more extensive burns there are significant additional costs related to reconstructive surgery and rehabilitation efforts. Lastly, mortalities are higher for children younger than age 4 (especially for children from birth to age 1), and for adults over age 65.

Why is the skin important?
Burn injuries involve the partial or complete destruction of the integumentary system: the skin. The layers of the skin are destroyed and this results in local and systemic disturbances. The skin is one of the largest organs of the body and has many functions including acting as a protective barrier against injury and infection, thermoregulatory control, regulation of fluid loss, synthesis of vitamin D, and sensory contact with the environment. When the skin is damaged or destroyed by a burn, it may result in or lead to compromised immunity, hypothermia, increased fluid loss, infection, changes in appearance, function, and body image.

The skin is divided into three layers: the epidermis, dermis, and subcutaneous tissue. Burn injuries are described by the causative agent, depth, and severity. In the past, burn injuries were classified as first, second, third, and occasionally fourth degree. In recent years, the ABA has recommended a more precise definition of first-, second-, and third-degree burns, categorizing them according to depth of skin destruction: epidermal or superficial (first-degree), partial-thickness (second-degree), which may also be classified as superficial or deep partial-thickness) and full-thickness (third-degree) burns (may also be classified as a deep full-thickness). (See The skin and degrees of burns.)

Size matters
The size of the burn is expressed as the percentage of TBSA. A partial-thickness burn of more than 10% TBSA is serious and needs referral to a burn center (see Should my patient go to a burn center?).

You can estimate the TBSA burned on an adult by using 9 or multiples of 9, known as the Rule of Nines. The Rule of Nines varies between infants and adults because infants’ heads are proportionally larger compared to adults (see Rule of Nines: Estimating burn size in adults). Although the Rule of Nines provides a rapid method for calculating the size of
the injury, it can overestimate the TBSA burned, so follow your facility's protocol for estimating the extent of a burn injury. Most burn centers repeat the estimation of TBSA burned in 72 hours, when burns and their depth are more clearly demarcated and the burned area can be more easily quantified.5

Other common methods for measuring burn size include the Lund and Browder chart and the "rule of palms." The Lund and Browder method is highly recommended because it corrects for the large head-to-body ratio of infants and children.6 The rule of palms is used for small scattered burns such as grease and scald burns. Often, the rule of palms will be completed first as a quick assessment until the Lund and Browder assessment can be completed. The patient's palm (not including the fingers or wrist area) equals 1% TBSA.

**Types of burns**
A burn injury is described based on its cause: thermal, chemical, electrical, radiation, smoke or inhalation, or frostbite.

- **Thermal burns** result from contact with hot substances by coagulation,

**The skin and degrees of burns**

- The epidermis is the nonvascular outer layer of the skin and is as thick as a sheet of paper. The epidermis is a protective barrier for the skin, holding in fluids and electrolytes and aiding in body temperature regulation.
- The dermis lies beneath the epidermis and is 30 to 45 times thicker than the epidermis. Connective tissues with blood vessels, hair follicles, nerve endings, and sweat glands are found in the dermis.
- Under the epidermis is the subcutaneous tissue, which contains major vascular networks, nerves, fat, and lymphatics. The subcutaneous tissue acts as a heat insulator for underlying structures, including the muscles and internal organs.

- **Superficial burns** caused by the sun or low-intensity heat flashes damage only the epidermis. These first-degree burns cause erythema, skin blanching on pressure, mild pain and swelling, and no blisters or vesicles, although after 24 hours the skin may blister and peel. Symptoms include hyperesthesia, mild pain, and tingling. Healing typically takes 3 to 6 days.

- **Partial-thickness burns** caused by chemicals, flame, or hot liquids damage the epidermis and part of the dermis. These second-degree burns appear as fluid-filled vesicles that are red and shiny (and wet if the vesicles have ruptured). Symptoms include edema, hyperesthesia, pain caused by nerve injury, and sensitivity to cold air. Healing typically takes 10 to 21 days for superficial partial-thickness burns, which involve part of the dermis, and 2 to 6 weeks for deep partial-thickness burns, which involve more of the dermis.

- **Full-thickness burns** may extend into the subcutaneous tissue, meaning the skin can't heal on its own. These burns, classified as third- and fourth-degree burns, are caused by prolonged exposure to chemicals, electrical current, flame, hot liquids, or tar. The skin appears dry, waxy, white, leathery, or hard. Thrombosed vessels will be visible, and muscles, tendons, and bones may be involved. Signs and symptoms include lack of pain, possible hematuria, possible entrance and exit wounds from an electrical burn, and shock. Skin grafting is often required for healing, and patients may lose function of extremities or digits, or need amputation.
including flame, hot liquids, hot solid objects, and steam. The longer the skin is in contact with these hot substances the deeper the wound. Oil-based liquids such as grease and cooking oil have higher boiling points, and cause deeper burns than scalds with water or other liquids. Burns from hot solid objects such as solid metal, hot plastic, glass, or stone are all considered thermal burns.

- **Chemical burns** destroy tissue and continue to do damage up to 72 hours unless neutralized. Causes of chemical burns are strong acids, alkalis, and organic compounds. Acids are commonly found in household cleaners such as rust removers and bathroom cleaners, and cause protein coagulation, which results in less extensive injuries. Alkalis such as oven cleaners and fertilizers cause deeper burns due to liquefaction necrosis of tissue, which lets the chemical penetrate deeper into tissues. Organic compounds that cause chemical burns include gasoline and chemical disinfectants, which can cause severe coagulation necrosis and produce a layer of thick, nonviable tissue called eschar, which is normally present in full-thickness burns.

- **Electrical burns** are classified as low voltage (under 1,000 volts) or high voltage (1,000 volts or higher). Electrical injuries can cause death by producing ventricular fibrillation or paralysis of the respiratory muscles; dysrhythmias can occur with low voltage, but are more commonly seen in high-voltage injuries. The extent of damage from an electrical burn may initially appear minor—the patient may only have small entry and exit wounds. Extensive damage can appear within several days to weeks, a phenomenon known as the iceberg effect because the skin surface shows little injury and hides massive injury beneath. Instead of conducting the electricity, bones, muscle, tendon, and fat respond to electrical injury by producing heat. Most injuries occur to muscles surrounding the long bones.

- **Radiation burns** result from exposure to sunlight, tanning booths, X-rays, or nuclear emissions or explosions. Ionizing radiation can produce tissue damage directly by striking a vital molecule such as DNA. Sunburn is usually a first-degree or superficial burn, but radiation therapy can cause full-thickness burns.

- **Smoke and inhalation burns** can occur concurrently with thermal or chemical burns. If the patient has thermal burns, the signs of inhalation burns are facial burns, hoarseness, soot in the nose or mouth, carbon in the sputum, lip edema, and singed eyebrows or nasal hair. Manufacturing of illegal methamphetamine can cause thermal and chemical burns and associated inhalation burns. Regardless of the cause of the inhalation injury, the patient needs immediate respiratory interventions such as bronchoscopy, endotracheal intubation, and measurement of carboxyhemoglobin (COHgb) levels.

- **Frostbite** is temporary or permanent tissue damage resulting from exposure to very cold temperatures. Any area left uncovered in very cold temperatures can become frostbitten, but the most commonly affected areas are the fingers, toes, chin, earlobes, cheeks, and nose. Blood flow to the skin’s outer layer is reduced and the skin tissue freezes and begins to die. Without treatment,

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**Should my patient go to a burn center?**

Patients who should be referred to a burn center include:

- All burn patients under age 1.
- All burn patients ages 1 to 2 with burns over 5% or more of TBSA.
- Patients of any age with full-thickness burns of any size.
- Patients over age 2 with partial-thickness burns greater than 10% of TBSA.
- Patients with burns of special areas such as the face, hands, feet, genitalia, perineum, or major joints.
- Patients with electrical burns, including lightning injuries.
- Patients with chemical burns.
- Patients with inhalation injury resulting from a fire or hot liquid burn.
- Patients with circumferential burns of the limbs or chest.
- Patients with preexisting medical conditions that could complicate burn management, prolong recovery, or affect mortality.
- Patients with burns and concomitant trauma.
- Children with burns who are suspected to be victims of child abuse.
- Patients whose burns require treatment that exceeds the capabilities of the referring facility.
- Patients with septic burn wounds.
frostbite can progress to necrosis, gangrene, hypothermia, and cardiac arrest. Because frostbite causes damage to the skin, some patients are treated in the ICU as burn patients, although initial treatment for frostbite is different than that for burns.

**Location matters**
The location of a burn injury can predispose a patient to initial complications or complications during healing. Circumferential burns of the extremities can lead to vascular compromise resulting in compartment syndrome, and circumferential burns to the thorax can impair chest wall expansion, causing pulmonary insufficiency. Burns of the chest, head, and neck are also associated with pulmonary complications. Facial burns are associated with corneal abrasions, burns of the ears with auricular chondritis, and burns of the perineal area are prone to autocontamination by urine and feces. Lastly, burns over the joints immediately affect the patient’s range of motion, which may be exacerbated later by hypertrophic scarring. Intensive therapy to prevent permanent disability is crucial.

**The body’s response to burns**
Understanding the pathophysiology of a burn injury (sometimes called burn shock) is key to effective management. Different causes lead to different burn injury patterns, which require different management.

The body’s compensatory mechanisms start with the inflammatory response, which is initiated by cellular injury. The most important activator of the inflammatory response is the mast cell, which releases biochemical mediators, such as histamine and chemotactic factors, and synthesizes other mediators, such as prostaglandins and leukotrienes. Histamine, the major vasoactive amine released by the mast cells, causes increased capillary permeability and exudation resulting in edema, decreased intravascular volume, hypotension, tachypnea, tachycardia, oliguria, and shock. The sympathetic nervous system (SNS) is stimulated and the fight-or-flight response activated, causing thirst, gastrointestinal hypomotility (ileus), adrenal stimulation (causing increased catecholamine secretions, increased metabolic rate, and increased aldosterone secretion), hepatic stimulation (causing release of glycogen stores), increasing blood glucose levels, and vasoconstriction.

**Rule of Nines: Estimating burn size in adults**

Source: Anatomical Chart Company. Pathology/Laboratory Medicine; 2008.

Circumferential burns of the extremities can lead to compartment syndrome.
Burns affect every body system:

- **Respiratory system effects** include direct airway injury; inhalation injury; carbon monoxide poisoning; smoke inhalation [damage to epithelial cells in the lower respiratory tract secondary to inhaling oxides, the products of combustion]; alveolar damage; pulmonary edema; and decreased oxygen diffusion.\(^8\)

- **Cardiovascular system effects** include fluid volume deficit, decreased mean arterial pressure, decreased cardiac output, hypovolemic shock [secondary to extensive fluid shifts], and decreased myocardial contractility [impaired cardiac function improves 24 to 30 hours postinjury].\(^9\) Electrical burns can cause ECG changes, myocardial infarction, ventricular fibrillation, and cardiac arrest.\(^9\)

- **Renal system effects** are indirect. Decreased cardiac output leads to decreased renal perfusion and oliguria that can culminate in acute kidney injury (AKI). In addition, after a burn injury, damaged red blood cells release hemoglobin and potassium, and skeletal muscle cells release myoglobin. Both hemoglobin and myoglobin are filtered by the glomerulus and degraded, releasing heme pigment. Heme pigment, especially in the setting of fluid volume deficit, can cause AKI.\(^{14}\) Marked release of hemoglobin or myoglobin usually causes red or brown urine.

- **Gastrointestinal system effects** include ileus secondary to SNS activation. Stress ulcer formation is triggered by the stress response and the histamine released in the inflammatory response. Intra-abdominal hypertension and abdominal compartment syndrome can damage the gut, kidneys, and liver.\(^{5,9}\)

- **Neuroendocrine system effects** include increased metabolic rate to compensate for the initial low core body temperature due to loss of skin. The increased metabolic rate increases caloric needs and leads to catabolism and a negative nitrogen balance that slows tissue building and healing.\(^9\) Increased cortisol levels may cause insulin resistance and hyperglycemia.\(^{13}\)

- **Immune system effects** include immunosuppression secondary to the immediate, prolonged, and severe immunologic and inflammatory response to a major burn injury.\(^{13}\)

- **Musculoskeletal system effects** include contractures and complications secondary to immobility and the healing process.

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**Assessment and initial management**

The emergency management of a patient with a burn injury begins with the initial assessment and treatment of life-threatening injuries. Stabilize the patient’s cervical spine if this hasn’t already been done. The true mechanism of injury may not be clear [for example, the patient may have been burned and propelled in an explosion].

Follow these specific aspects of the ABCDE (Airway, Breathing, Circulation, Disability, and Exposure/Environmental control) assessment:\(^{5,9,15}\)

- **Airway.** The airway is the primary concern, especially if a patient has an inhalation injury. Assess for stridor [an ominous sign that suggests the patient’s upper airway is at least 85% narrowed], facial burns, soot in the nares or mouth, singed facial hair or nasal hair, edema of the lips and oral cavity, coughing, hoarse voice, and circumferential neck burns.\(^{5,9}\)

- **Breathing.** Determine adequacy of ventilation by assessing the patient’s respiratory rate and depth and observing for dyspnea and adventitious breath sounds. Obtain a pulse oximetry reading [remembering that it may be inaccurate in the presence of carbon monoxide], and a co-oximetry reading if indicated and available.\(^{5,9,15}\)

- **Circulation.** Assess for the presence, rate, and rhythm of pulses; evaluate capillary refill time, skin color, and temperature; and observe for obvious arterial bleeding.\(^5\)

- **Disability.** Use the AVPU (Alert, Verbal, Pain stimuli, Unresponsive) Scale [see A look at the Troublesome scars]

Hypertrophic scarring of a deep partial-thickness burn can cause pruritus, warmth, and other patient discomfort, and the raised scar can limit function if joints are affected.

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Troublesome scars

Hypertrophic scarring of a deep partial-thickness burn can cause pruritus, warmth, and other patient discomfort, and the raised scar can limit function if joints are affected.
Caring for patients with burn injuries

The care of the burn patient is organized into three overlapping stages: emergent (resuscitative), acute (wound healing), and rehabilitative (restorative).5 The assessment and management of specific problems aren’t limited to these stages and take place throughout the care of patients with burn injuries. For example, rehabilitation begins on the first day after the burn injury, with the formal rehabilitative phase beginning when the burn wound is almost healed.15

About fluid resuscitation
Fluid resuscitation efforts are started as soon as possible for patients with burns of more than 15% of TBSA; otherwise, the patient may experience hypovolemic shock.9 Insert an indwelling urinary catheter to monitor fluid balance. Fluid resuscitation is usually accomplished with an isotonic crystalloid such as lactated Ringer’s solution; the lactate helps to buffer the metabolic acidosis commonly seen with hypoperfusion and burn shock.9 Several fluid resuscitation formulas are available, and a formula usually is prescribed by the burn trauma surgeon.

All formulas are based on the percentage of TBSA burned, the patient’s weight in kilograms (kg), and the patient’s age. Half of the fluid volume is administered in the first 8 hours post-burn, and the remainder is given over the next 16 hours. The ABA recommends titrating the fluids to maintain a urine output of 30 to 50 mL/hour in adults and 1 mL/kg/hour in children weighing less than 30 kg.9 In the case of a patient who has sustained a high-voltage electrical burn, the target range for urine output is 75 to 100 mL/hour to prevent renal...

AVPU scale to determine the patient’s level of consciousness and carefully evaluate any abnormalities. Assess for hypoxia, decreased cerebral perfusion related to hypovolemia, and cerebral injury resulting from head trauma. Assess the patient’s pupillary response to light and sensory and motor function.3,9

• Exposure/environmental control. Gently remove the patient’s nonadherent clothing and jewelry to prevent continued tissue damage. If the patient’s face is burned, remove glasses or contact lenses. Cover the patient with a dry sterile sheet to prevent further contamination of the burn wounds and to provide warmth.3,5,6,15

Obtain vital signs and establish I.V. access with two large-bore catheters if the patient has burns over 15% or more of TBSA. Elevate burned extremities above heart level to decrease edema. Administer I.V. analgesia as prescribed and assess its effectiveness often, using a valid and reliable pain intensity rating scale.

After the initial focused assessment is completed and the patient is stabilized, obtain a history of the events while performing a comprehensive physical assessment. Your main priorities are to determine the potential for an inhalation injury, presence of concomitant injuries or trauma, and any preexisting conditions that may influence the physical assessment or patient outcomes. A simple way to initially accomplish this is to use the SAMPLE mnemonic: Signs and symptoms, Allergies, current Medications [including illegal substances or alcohol], Pertinent history, Last oral intake, and Events leading up to the injury.16 Determine the extent and depth of the burn, and ask the following questions:

• What is the patient’s chief complaint [for example, dyspnea or pain]?
• Did the burn occur in an enclosed space?
• Were explosives or chemicals involved?
• What was the source of the burning agent [for example, liquid, metal, or chemicals]?
• What is the status of the patient’s tetanus immunization?6

Stages of burn management

A look at the AVPU scale

This scale, a shortened form of the Glasgow Coma Scale, can be used to determine a patient’s level of consciousness.

Alert: patient is alert, awake, responds to voice, and is oriented to time, place, and person. You can obtain subjective information from the patient.

Verbal: The patient opens his or her eyes to verbal stimuli, but isn’t fully oriented to time, place, or person.

Painful: The patient responds to painful or noxious stimuli, such as a hand squeeze or sternal rub, but doesn’t respond to verbal stimuli.

Unresponsive: The patient is nonverbal and doesn’t respond to painful stimuli.

tubular obstruction from heme pigment. Avoid administering diuretics, which may aggravate dehydration. The patient’s mental status, vital signs, hourly urine output, and urine specific gravity, are valuable indicators of the patient’s response to fluid resuscitation.

Because of the massive volumes of I.V. fluids administered to burn patients (rates of 1,000 mL/hour are common), diligently assess the patient’s hemodynamic status to avoid inducing fluid overload. Signs and symptoms of “fluid creep,” or fluid resuscitation in excess of that predicted by the Parkland formula, include abdominal compartment syndrome, extremity compartment syndrome, and acute respiratory distress syndrome (ARDS). Fluid resuscitation after the first 24 hours is accomplished by using isotonic crystalloids as well as colloids. Dextrose solutions and electrolyte replacement (especially potassium replacement) is initiated. Lactated Ringer’s solution is isotonic and doesn’t increase intravascular oncotic pressure. Because of increased capillary permeability in patients with burns, only 25% of the lactated Ringer’s solution infused in the initial fluid resuscitation will actually stay in the intravascular space. This is one reason for the large fluid volumes needed in fluid replacement.

Once the increased capillary permeability has decreased (8 to 12 hours after the burn injury), colloids such as albumin may be given to help restore intravascular volume. Colloids increase the oncotic pressure in the vascular space, pulling interstitial fluid into the intravascular space. This helps decrease the edema associated with burn injuries.

Interventions for specific types of burns

For all patients, monitor vital signs, level of consciousness, respiratory status, oxygen saturation, and cardiac rate and rhythm. Identify and treat other associated injuries, such as head injury, pneumothorax, or fractures. Now let’s look at specific interventions for common types of burns:

- **Thermal.** Assess the patient for inhalation injuries. For adults with burns of more than 15% TBSA, begin fluid replacement as prescribed and insert an indwelling urinary catheter.
- **Chemical.** Assess the patient’s ABCs before starting decontamination procedures. Endotracheal intubation and mechanical ventilation may be needed for patients with significant inhalation injuries or circumferential full-thickness burns to the neck or chest. Remove dry chemicals from the patient’s skin, then use saline or tap water to flush chemicals from the burn. Contact the poison control center for more information on handling chemicals, and protect yourself from potential exposure.
- **Electrical.** Check pulses distal to the burn. Monitor the patient for myoglobinemia (myoglobin released from injured muscle tissue and hemoglobin from damaged red blood cells). Be prepared to administer I.V. mannitol, an osmotic diuretic, to maintain urine output, and I.V. sodium bicarbonate to alkalinize the urine.
- **Inhalation.** Obtain an arterial blood gas analysis, COHgb level, and chest X-ray. Be prepared if fiberoptic bronchoscopy or endotracheal intubation are needed.

A good start

By understanding the types of burns and how to assess and manage them, you can help patients until they can be transferred for specialized burn care. In future articles, we’ll describe managing burn patients in the ICU, skin grafting, and in-hospital rehabilitation.

REFERENCES

Caring for patients with burn injuries


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