Managing
burn injuries in the ICU

Prevent burn shock and keep your patient on the road to healing.

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In a previous article (Caring for patients with burn injuries, January 2013), we described the types of burns and assessment and initial management of burn-injured patients. This article focuses on managing burn-injured adult patients in the ICU.

Cardiovascular management
The priority nursing diagnoses for cardiovascular management are decreased cardiac output (CO) related to increased capillary permeability, fluid volume deficit related to loss of plasma from vascular space, and alteration in tissue perfusion related to decreased CO and edema.

Fluid resuscitation was addressed in the previous article, and is based on total body surface area (TBSA) burned as well as the patient’s weight and age. Fluids may be titrated to keep the adult patient’s urine output at the levels recommended by the American Burn Association (ABA): 0.5 mL/kg/hour.¹ ²

Diligently monitor the patient’s hemodynamic status: urine output, central venous pressure (CVP), CO, and mean arterial pressure (MAP). Lactated Ringer solution is the crystalloid of choice for the first 24 hours because it contains electrolytes, and lactate may reduce hyperchloremic acidosis, which can occur with the very large volumes of 0.9% sodium chloride solution administered to burn-injured patients.³ Hypertonic dextrose solutions and colloids may be administered when capillary permeability is restored. After the first 24 hours, colloid-containing solutions can help reduce edema and third-space fluid shifts by increasing oncotic pressure in the intravascular space and pulling fluid from the interstitial space.³

Some patients may need increased fluid resuscitation:
• patients with electrical burns are at risk for acute kidney injury (AKI) if myoglobin released from the damaged muscle cells precipitates in the renal tubules
• patients with inhalation injury.

Patients may be placed on digoxin to address myocardial dysfunction and decreased myocardial contractility after a burn injury. Cardiac dysfunction occurs secondary to activation of the complement system, which generates anaphylatoxins.⁴ Vasopressors, such as dopamine, also may be needed to help increase the patient’s CO. Monitor the patient’s cardiac rate and rhythm. Remember that age-related alterations and reduced physiologic reserve put older adults at an increased risk for developing atrial fibrillation after a burn injury.⁵

Burn-injured patients also are at risk for venous thromboembolism (VTE, the umbrella term for deep vein thrombosis [DVT] and pulmonary embolism [PE]), due to endothelial injury, hypercoagulability, and venous stasis. DVT occurs in 1% to 23% of burn-injured patients.⁶
Administer VTE prophylaxis as prescribed; intermittent pneumatic compression and low-molecular-weight heparin are typically used. If the patients’ legs are edematous from a burn injury, assessing leg edema from DVT is very difficult. Also, the burn pain can mask the patient’s discomfort from a DVT, so look for signs and symptoms of a PE, including dyspnea.4

If the patient has circumferential burns of the chest, abdomen, or extremities, an emergency decompressive escharotomy may be needed to accommodate tissue edema or relieve mechanical constriction interfering with respiration. The eschar in a circumferential burn can compress the blood vessels in an extremity, decreasing distal perfusion. If the abdomen or thorax is involved, an abdominal compartment syndrome can develop along with decreased lung expansion. The escharotomy is done at the bedside and doesn’t require analgesia because this dead tissue has no nerve endings. In addition, eschar is avascular, so blood loss is minimal. In some burn patients, a fasciotomy [incision down to the muscle fascia] may be needed.4

Postponing necessary escharotomies can result in limb loss and respiratory arrest.7

Respiratory management
A priority nursing diagnosis involving the respiratory system is ineffective breathing pattern related to inhalation injury and airway obstruction. As discussed in our previous article, the signs and symptoms of inhalation injury include facial burns, hoarseness, soot in the nose or mouth, carbon in sputum, lip edema, and singed eyebrows or nasal hair. You may also observe edema of the patient’s eyelids and other facial features, and note wheezes and stridor. Make sure that the patient’s airway is patent. Endotracheal (ET) intubation may become impossible if tracheal edema is severe. For this reason, most EDs intubate patients if the healthcare providers have any questions about airway patency.

Fiberoptic bronchoscopy is a simple, accurate, and safe method of diagnosing acute inhalation injury.8 Fiberoptic bronchoscopy also allows for oxygen delivery, deep suctioning, and removal of necrotic tissue. The ET tube should be secured without putting pressure on the ears or other burned areas. The head of the bed should be elevated to decrease airway edema and facial edema from fluid resuscitation, unless medically contraindicated.4

When burn-injured patients are admitted to the ED or the CCU, plan to obtain a chest X-ray and sputum culture and sensitivity. A patient with an inhalation injury usually is intubated and placed on mechanical ventilation. Aim to maintain a PaO₂ of greater than 90 mm Hg and an SaO₂ greater than 95%.4 Because these patients’ carboxyhemoglobin (COHb) levels typically are elevated, they’ll receive 100% oxygen until the COHb level is 5% to 10% or lower.4 Hyperbaric oxygen therapy may be indicated for some patients; this treatment displaces carbon monoxide from intracellular stores and may improve mitochondrial function.9 Hyperbaric therapy should be considered in patients with COHb levels greater than 40%, who are unresponsive, have other neurologic deficits, or have severe metabolic acidosis [pH < 7.1].9 If the patient has a circumferential burn of the thorax, an escharotomy may be necessary in order to deliver the proper tidal volume and rate and keep airway pressures to a minimum.8

Patients with inhalation injury also are treated for cyanide poisoning because of the number of products containing oil, according to an e-mail from Michael Morrissey (January 2013), a lieutenant with the Fire Department of New York. Cyanide, one of the toxins released when these products burn, inhibits intracellular cytochrome oxidase and leads to tissue asphyxiation, anaerobic metabolism, and lactic acidosis. The liver detoxifies cyanide to thiocyanate, which is excreted by the kidneys. Consider hemodialysis in any burn-injured patient with AKI.

Patients with severe inhalation injury may need a brief course of steroids; patients who were taking steroids before injury may experience adrenal insufficiency and should receive stress doses of steroids. Prophylactic antibiotics are discouraged due to the risk of encouraging resistant organisms, but appropriate antibiotics should be administered if a sputum, wound, or blood culture identifies bacterial infection. Bronchodilators may also be used to reverse bronchospasms.9

Patients with severe inhalation injury may need extracorporeal membrane oxygenation (ECMO), in which blood is oxygenated via machine before being returned to the body. By taking over lung function, ECMO lets the lungs heal. Patients who
develop acute respiratory distress syndrome may need paralytic agents such as cisatracurium to allow uninterrupted ventilation and better gas exchange.8-10

Although most pulmonary damage is self-limited and resolves in 2 to 3 days, patients with inhalation injuries may need a tracheostomy if prolonged mechanical ventilation is needed or at the surgeon’s discretion.5 In the past, tracheostomy was discouraged due to pulmonary contamination with burn wound bacterial flora. But advances in burn care mean that tracheostomy no longer increases pneumonia risk in burn patients.10

Nursing care includes meticulous pulmonary hygiene to decrease the patient’s risk of developing ventilator-associated pneumonia (VAP). Interventions to decrease VAP risk include regular oral care, eliminating cross-contamination when suctioning, and elevating the head of the bed 30 to 45 degrees unless medically contraindicated. Also assess the patient’s breath sounds, and monitor for tachypnea, fever, leukocytosis, pulmonary infiltrates, and purulent secretions.4 Turn and reposition the patient at least every 2 hours, perform chest physical therapy, and encourage ambulation.

**Integumentary management**

Priority nursing diagnoses for integumentary management include preventing further loss of skin integrity and restoring skin integrity. Assess the burn wound frequently for signs of infection and dysfunctional wound healing. Remember that immunosuppression means that burn-injured patients may not have the typical signs and symptoms of infection, such as a fever. Patients with extensive burns are considered immunosuppressed because the burn destroys the skin barrier to pathogens, and cytokine and neutrophil activity are altered. Pathogens can colonize burn eschar and enter the tissues, causing secondary bacteremia.2

Your major focus related to burn wound management is debridement, which removes eschar and other cellular debris from the burn wound to promote skin restoration by natural wound healing or grafts. Debridement can be accomplished mechanically, enzymatically, or surgically.

**Mechanical debridement** is often done via hydrotherapy. Shower trolleys let water flow over the burn wound and immediately drain away (eliminating the contamination problems of older hydrotherapy tubs and tanks). Hydrotherapy allows for visualization and cleaning of the burn wound. During this therapy, previously applied topical agents, exudate, necrotic tissue, and fibrous debris are removed from the wound to expose healthy tissue.

Other methods of mechanical debridement include wet-to-dry dressings, which may damage newly formed viable tissue.

**Enzymatic debridement** involves applying topical proteolytic enzyme ointments that digest necrotic tissue. Enzymatic debridement is usually performed on deep partial or full-thickness burns that cover a small area.4

**Surgical debridement** is done early in the burn rehabilitation process, typically 1 to 3 days postinjury. Performed in the OR, surgical debridement involves excising necrotic tissue until brisk punctate bleeding occurs, indicating a wound that’s ready to be grafted. Because surgical debridement can cause a great deal of blood loss, patients may require multiple blood transfusions. A skin graft or temporary covering is placed over the excised wound. Early surgical debridement decreases the number of hydrotherapy treatments that the patient will need to clean the wound and prepare it for grafting.4

**Dealing with dressings**

Various dressings—standard wound, biologic, or biosynthetic—can be used on burn wounds.

The **standard wound dressing** consists of applying a thin layer of topical antibiotic to the area, covering the wound with a fine, nonadherent, mesh...
Keeping pain at bay

Burn-injured patients have acute pain related to burn injury and treatments, and pain related to exposed nerve endings in damaged dermis. Diligently assess the patient’s need for and response to pain medication, with the ultimate goal of the patient reporting pain relief and satisfaction with the level of pain control. Pain can be:

- **background**—pain that’s present while the patient is in a resting state, and is of lower intensity and longer duration than acute pain.
- **procedural**—an intense, short-lived pain produced by wound care, activities, or therapies.
- **breakthrough**—pain that breaks through the ongoing treatment for persistent pain.

Breakthrough pain, called episodic pain in non-English-speaking countries, is rapid in onset and relatively short in duration. Whereas persistent pain is constant and lasts for a long time, breakthrough pain is sudden and severe, with an average duration of 30 minutes.

- **chronic**—pain that lasts longer than 6 months, and can be a challenge for outpatient and ongoing therapy.

Pain from nerve damage is treated differently than conventional burn pain. The nursing management of pain often overlaps throughout the stages of a burn injury. However, general nursing interventions associated with each phase or stage include using a reliable pain intensity rating tool, administering analgesics before performing painful procedures, administering I.V. analgesics as prescribed, explaining all procedures and the expected associated level of discomfort, using nonpharmacologic methods of pain management in combination with analgesics, and encouraging the patient to verbalize the pain experience.

I.V. analgesia is recommended during the acute postburn period because shock or paralytic ileus can impair gastrointestinal function. Avoid I.M. injections because the medication isn’t absorbed adequately in burned or edematous areas, and can pool in the tissues. When fluid mobilization does begin, the patient may be inadvertently over- or undermedicated from the interstitial accumulation of previously received I.M. injections.

A variety of analgesics are used for burn-injured patients, including morphine, sustained-release morphine, oxycodone/acetaminophen (Percocet), fentanyl, methadone, and gabapentin.

I.V. morphine is the drug of choice for treating pain in burn-injured patients. Dosages may be administered every 5 to 10 minutes during procedures such as wound care; remember that depending on the severity and extent of the injury, burn-injured patients may require much higher doses compared with patients without burn injuries. In the case of central nervous system depression from a morphine overdose, administer naloxone, an opioid-receptor antagonist.

Continuous I.V. infusions of morphine typically are reserved for severely burned patients who need mechanical ventilation. Morphine may be delivered via a patient-controlled analgesia (PCA) pump for severe background pain. The PCA pump is ideal for patients who are neurologically intact and can actively participate in their pain management.

Mild-to-moderate background pain can be treated with oral oxycodone/acetaminophen in patients who are hemodynamically stable and whose ileus has resolved.

Because burn-injured patients usually receive higher-than-normal morphine dosages, closely monitor the patient’s vital signs, level of consciousness, respiratory rate and rhythm, end-tidal carbon dioxide levels, and oxygen saturation. Be alert for signs and symptoms of opioid-induced sedation, respiratory depression, and hypotension, and have emergency equipment readily available. Morphine-induced hypotension may occur in patients who have hypovolemia due to burn shock or sepsis.

As the patient enters the rehabilitative stage of burn management, consider alternative pain management therapies such as self-hypnosis, distraction, music, guided imagery, and relaxation techniques. These therapies can be used in combination with medications, and treatment should be individualized, reevaluated over time, and modified as needed.
Biologic dressings are used to protect granulation tissue in patients with partial-thickness burns. These dressings also are used as a temporary skin cover to decrease infection, heat loss, and pain. Xenografts are usually pig skin, which can be replaced on a continual basis until the wound heals or an autograft is completed (patients typically reject the xenograft within 24 to 72 hours).

Biologic dressings also can be homografts or allografts (skin from a cadaver or live donor), which is typically rejected after about 10 days. Biosynthetic dressings are applied directly to the surface of a clean or surgically prepared wound and can be kept in place for 2 to 5 days. These dressings also are used to cover donor sites, unburned areas, and full-thickness burned areas that have been prepared for grafting.

Autografts transplanted from unburned areas on the patient's body are used as permanent wound coverings for full-thickness burns. The most common skin graft is the split-thickness skin graft, which includes the entire epidermis but the dermal layer is split by the dermatome blade. Full-thickness skin grafts include the epidermis, dermis, hair follicles, and nerve endings. The donor sites generally heal within 7 days and can be used at a later time for more split-thickness skin grafts. If the donor site becomes infected, it will need to be grafted and treated like a full-thickness burn site. Grafts usually are secured to the burn wound by surgical staples, dressed, and the affected area kept immobile for 3 to 7 days.

Cultured skin grafts also can be used as a permanent wound cover, and are grown from the patient’s epithelial cells. However, these autografts address the epidermal layer only and are typically fragile and thin. A cultured epidermal autograft (CEA) uses a small biopsy from the burn patient’s healthy skin that is expanded via culture techniques in the lab to produce a sheet of autogenous keratinocytes for grafting. CEAs have been associated with a high rate of infection and graft loss, confirming the importance of the dermal layer. Cultured skin substitutes (CSS) are composed of CEA combined with a cultured autologous dermal layer, and are thicker and less fragile than CEAs.

Negative pressure wound therapy (NPWT), a newer treatment, is used to treat grafts, partial-thickness burns, and deep surgical wounds. In NPWT, a special sponge, connected to suction tubing, is placed on the wound bed and covered with a transparent dressing. The negative pressure decompresses edematous interstitial spaces, removes wound fluid, and increases local perfusion, helping to heal wounds. Patients also typically wear a custom-made pressure garment for 6 to 12 months after skin grafting to prevent or reduce hypertrophic scarring.

As burn wounds heal, they cause pruritus, which can interfere with the patient’s ability to sleep. As prescribed, administer diphenhydramine for the itching and sleep aids.

## Keeping infection at bay

The priority nursing diagnosis for infection management is risk for infection related to altered skin integrity and immunosuppression. Systemic infection is a leading cause of death for patients with major burns. Patients may develop transient...
bacteremia from a burn wound infection that could lead to sepsis.14

Other sources of infection can include invasive monitoring, peripheral and central venous catheters, urinary catheters, ET tubes, and treatments (such as debridement).5,6,14 In some cases, these inventions may be a necessary adjunct to the patient’s medical regimen. For example, peripheral and central venous catheters should be inserted through an area of normal or unburned skin to minimize infection risk. If the patient has extensive burns, the healthcare provider may need to cut down through the burn wound into a usable vein or artery.15 Common strategies to reduce the risk of intravascular catheter-associated infections include using catheters impregnated with antibiotics or an antiseptic, and rotating peripheral catheter insertion sites every 72 hours.15

To fight infection:
• Monitor the burn wound daily for general signs and symptoms of infection. Remove all topical medications and wound exudate so you can see the entire wound. Local signs of burn wound infection include wound progression from partial-thickness to full-thickness, rapidly extending cellulitis affecting healthy periwound skin, rapid eschar separation, and tissue necrosis.15
• Culture all body secretions and wounds as indicated.
• Administer antimicrobial therapies as prescribed, based on culture and sensitivity results.
• Monitor blood culture results for possible bacteremia.
• Assure that the patient is up-to-date with tetanus immunization; burn patients are at risk for anaerobic infection caused by Clostridium tetani.
• Monitor for signs and symptoms of a urinary tract infection.
• Monitor white blood cell counts and report leukocytosis, which may indicate infection.
• Monitor vital signs as prescribed, remembering that in a patient with major burns, fever in the absence of other signs and symptoms of infection doesn’t indicate infection. Burn-injured patients have a hypermetabolic response that automatically increases their core temperature (see Hypermetabolism in burn injury).
• Monitor for signs and symptoms of pneumonia.
• Maintain appropriate nutritional support.
• Maintain an aseptic environment at all times, and use standard precautions and sterile procedures when indicated.
• Avoid cross-contamination during wound care. Wear a cap, mask, gown, and gloves; perform hand hygiene before and after contact; expose, clean, and rewrap uninfected areas first.
• Be aware that cross-contamination can occur from the air, healthcare providers, and visitors. Visitors who are ill shouldn’t be permitted to see the patient.
• Avoid auto-contamination from the oropharynx, fecal flora, and unburned skin.5,6,14

To avoid encouraging antibiotic resistance, healthcare providers rarely prescribe antibiotics prophylactically in burn-injured patients.5 Systemic antibiotics are prescribed and administered only for patients with documented wound sepsis or other positive culture.

**Hypermetabolism in burn injury**

Patients with burn injuries have hyperdynamic circulatory, physiologic, catabolic, and immune system responses. Muscle wasting, increased body temperature, increased infection risk, and peripheral insulin resistance are some characteristics of this hypermetabolic state, which begins within 5 days of a major burn injury and can last as long as a year. Persistent elevations of stress mediators such as serum cytokines, catecholamines, and basal energy requirements, as well as impaired glucose metabolism and insulin sensitivity, may last for up to 3 years after a severe burn injury.

The cause of hypermetabolism isn’t well understood, but may be regulated by interleukins 1 and 6, platelet-activating factor, tumor necrosis factor, endotoxin, neutrophil-adherence complexes, reactive oxygen species, nitric oxide, and coagulation and complement cascades. As these cascades respond to burn injury, their mediators and byproducts appear to stimulate the persistent and increased metabolic rate.

**Nutritional management**

The priority nursing diagnosis for nutritional management is nutritional imbalance related to increased metabolic demands due to stress and the physiologic demands of wound healing.5,6,14 The patient’s resting energy expenditure can be double its normal level due to heat loss from the burn wound, pain, infection, and an increase in beta-adrenergic activity.5 Some patients may need 4,000 to 6,000 kcal per day. The daily estimated caloric
needs are regularly calculated by a dietitian and readjusted as the patient’s condition warrants. The goals of care are to provide optimal nutrition, maintain skeletal muscle, prevent patient weight loss, promote wound healing and graft adherence, prevent sepsis, and achieve an anabolic state and a positive nitrogen balance.

Nutrition (enteral, parenteral, or a combination) generally is initiated immediately or 24 to 72 hours postinjury. For enteral feedings, a nasointestinal feeding tube is placed under fluoroscopy into the duodenum or jejunum; the tip of the tube should extend past the pyloric sphincter to prevent reflux and aspiration. Enteral feedings are contraindicated if the patient has a Curling ulcer, bowel obstruction, septic ileus, pancreatitis, or a feeding intolerance. Parenteral nutrition is only started when the enteral route can’t be used due to the risk of infection related to the central venous access device. Specific indications for parenteral nutrition include inadequate enteral intake due to clinical status, weight loss greater than 10% of normal body weight, prolonged wound exposure, or debilitated condition before injury. When the patient can tolerate an oral diet, a high-calorie, high-protein diet with vitamin and mineral supplements is prescribed. Monitor the patient for evidence of feeding intolerance such as diarrhea, constipation, emesis, excessive gastric residual, or abdominal distension. Weigh the patient daily, and monitor serum protein, iron, glucose, and albumin levels. Subtherapeutic values indicate inadequate nutritional intake.

Mobility management
A nursing diagnosis associated with mobility management is impaired physical mobility and ability to perform self-care related to contractures, splinting, or immobilization after skin grafts. As burn wounds heal, contractures can develop and significantly limit mobility, especially if a joint is involved. Your goals are to help your patient avoid permanent joint dysfunction and return to his or her normal routine with no or few adjustments.

Physical therapy should begin at the early stages of treatment, with ambulation and a planned exercise regimen starting as soon as the patient’s condition stabilizes. Intervene to prevent contracture development and implement measures to decrease edema that interferes with normal range of motion (ROM) and mobility, such as elevating burned extremities as indicated. Facilitate mobility by optimizing pain management.

Other interventions used to combat the complications of immobility include deep-breathing exercises, turning, and proper positioning to prevent complications of immobility, such as atelectasis and pneumonia. By understanding the many facets of care for a burn-injured patient, you can help support your patient, anticipate his or her needs, and help produce a positive outcome.

Dealing with body image issues
The burn-injured patient suffers profound losses. These may include not only the loss of body image due to the burn injury, but also losses of ability to work, personal property, loved ones, and home. As a result, you must constantly assess the patient’s psychosocial status. Questions you should consider include:

- What are the patient’s concerns or fears?
- Does the patient feel powerless?
- Is the patient afraid of being rejected by family and loved ones?
- Does the patient have concerns or fears concerning sexual function?
- Does the patient have fears of being unable to cope with pain or physical appearance?

Being aware of these anxieties and the patient’s fears will better prepare you to provide support and request referrals specific to the patient needs. As it relates to body image disturbance, the goal of care is for the patient to adapt to the altered body image. You can assess the patient’s response by his or her ability to verbalize feelings related to the altered body image and acceptance of physical appearance, interest in resources that may improve function and appearance (such as wigs, cosmetics, and prostheses), and readiness to socialize with family and his or her usual social groups.

REFERENCES

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RESOURCES


At Duquesne University’s School of Nursing, Alicia L. Culleton is an assistant clinical professor and Lynn M. Simko is an associate clinical professor.

The authors have disclosed that they have no financial relationships related to this article.

DOI: 10.109701.CCN.0000427723B.05970.5e