chapter 57

Management of Patients With Burn Injury

LEARNING OBJECTIVES

On completion of this chapter, the learner will be able to:

1. Discuss the incidence of burn injury in the United States today.
2. Describe the factors that affect the severity of burn injury.
3. Describe the local and systemic effects of a major burn injury.
4. Compare and contrast the potential fluid and electrolyte alterations of the emergent/resuscitative and acute phases of burn management.
5. Describe the goals of burn care and the nurse's role in wound assessment, wound cleansing, topical antibacterial therapy, wound dressing, débridement, excision, and skin grafting.
6. Describe the nurse's role in pain management, restoration of function, psychological support of the patient and family, nutritional support, pulmonary care, and patient and family education.
7. Describe patient care and the recovery process for burn patients

GLOSSARY

AlloDerm: processed dermis from human cadaver skin; can be used as dermal layer for skin grafts
autograft: a graft derived from one part of a patient's body and used on another part of that same patient's body
Biobrane: synthetic dressing composed of a nylon, Silastic membrane combined with a collagen derivative
carboxyhemoglobin: a compound of carbon monoxide and hemoglobin, formed in the blood with exposure to carbon monoxide
collagen: a protein present in skin, tendon, bone, cartilage, and connective tissue
contracture: shrinkage of burn scar through collagen maturation
cultured epithelial autograft (CEA): autologous epidermal cells that proliferate in culture and then are regrafted onto the patient
débridement: removal of foreign material and devitalized tissue until surrounding healthy tissue is exposed
donor site: the area from which skin is taken to provide a skin graft for another part of the body
eschar: devitalized tissue resulting from a burn
escharotomy: a linear excision made through eschar to release constriction of underlying tissue
excision: surgical removal of tissue
fasciotomy: an incision made through the fascia to release constriction of underlying muscle
heterograft: graft (ie, pigskin) obtained from an animal of a species other than that of the recipient; also called a xenograft
homograft: a graft transferred from one human (living or cadaveric) to another human; also called allograft
hydrotherapy: cleansing of wounds through use of bath, shower, shower cart table, or immersion
hypertrophic scar: excessive scar formation that rises above the level of the skin
Integra: synthetic dermal substitute
rule of nines: method for calculating body surface area burned by dividing the body into multiples of nine

The nurse who cares for a patient with a burn injury requires a high level of knowledge about the physiologic changes that occur after a burn, as well as astute assessment skills to detect subtle changes in the patient's condition. The patient's health history affects burn care. This makes each burn patient very unique and provides a variety of challenges to the patient's plan of care. In addition, the nurse provides sensitive, compassionate care to patients who are critically ill and initiates rehabilitation early in the course of care. The nurse must also be able to communicate effectively with patients who have burn injuries, family members in crisis, and members of the entire interdisciplinary burn management team. Care of the patient with a burn requires knowledge and skill throughout the care continuum from injury to recovery. This ensures quality care, improved patient outcomes, and optimal quality of life.

Overview of Burn Injury

Incidence

A burn injury can affect people of all age groups, in all socioeconomic groups. An estimated 500,000 people are treated for minor burn injury annually (Pitts, Niska, Xu, et al., 2008). The number of patients who are hospitalized each year with burn injuries is more than 40,000. This includes approximately 25,000 people who require hospitalization in specialized burn centers across the country. As emergency transportation and awareness of burn specialized hospitals has increased, the number of patients referred to these centers has risen. The remaining 5,000 hospitals see an average of three burns per year. Of those people admitted to burn centers, 47% of their injuries occurred at home, 27% on the road, 8% are occupational, 5% are recreational, and the remaining 13% from other sources. Forty percent of these injuries were flame related, 30% scald injuries, 4% electrical, 3% chemical, with the remaining unspecified (Miller, Bessey, Lentz, et al., 2008).

Males have greater then twice the chance of burn injury than women, and the most frequent age group for contact burns is between 20 to 40 years of age (Miller, et al., 2008). The National Fire Protection Association reports 4,000 fire and burn deaths each year. Of these, 3,500 deaths occur from residential fires and the remaining 500 from other sources such as motor vehicle crashes, scalds, or electrical and chemical sources. The overall mortality rate, for all ages and for total body surface area (TBSA) burned is 4.9% (Miller, et al., 2008).

Gerontologic Considerations

Reduced mobility, coordination, strength, and sensation and changes in vision place elderly people at higher risk for burn injury. Difficulties cooking and bathing and other activities of daily living are associated with flame and scald injury in this age group. These changes also place older people at risk for severe burn because they have difficulty in extinguishing the fire and removing themselves from the burn source (Sheridan, 2007a).

Morbidity and mortality rates associated with burns are greater in elderly patients than in younger patients when comparing injuries with similar severity. In 2007 patients over the age of 60 who had a 60% TBSA or greater had an overall mortality rate of 96% (Sheridan, 2007a). Predisposing factors and the health history in the older adult influence the complexity of care for the patient. Pulmonary function is limited in the older adult, therefore, airway exchange, lung elasticity, and ventilation can be affected. This can be further affected by a history of smoking. Decreased cardiac function and coronary artery disease increase the risk of complications in elderly patients with burn injuries. Malnutrition and presence of diabetes mellitus or other endocrine disorders present nutritional challenges and require close monitoring. Varying degrees of orientation may present themselves on admission or through the course of care, making assessment of pain and anxiety a challenge for the burn team. The skin of the elderly is thinner and less elastic, which affects the depth of injury and its ability to heal (Sheridan, 2007a).

An important goal of nurses in community and home settings is to provide education on the prevention of burn injury, especially among the elderly (Chart 57-1). Nurses

CHART 57-1 HEALTH PROMOTION
Burn Prevention

- Advise that matches and lighters be kept out of the reach of children.
- Emphasize the importance of never leaving children unattended around fire or in bathroom/bathtub.
- Advise the installation and maintenance of smoke detectors on every level of the home, changing batteries annually on birthday.
- Recommend the development and practice of a home exit fire drill with all members of the household.
- Advise setting the water heater temperature no higher than 120°F.
- Caution against smoking in bed, while using home oxygen, or against falling asleep while smoking.
- Caution against throwing flammable liquids onto an already burning fire.
- Caution against using flammable liquids to start fires.
- Caution against removing the radiator cap from a hot car engine.
- Recommend avoidance of overhead electrical wires and underground wires when working outside.
- Advise that hot irons and curling irons be kept out of the reach of children.
- Caution against running electric cords under carpets or rugs.
- Recommend storage of flammable liquids well away from a fire source, such as a pilot light.
- Advocate caution when cooking, being aware of loose clothing hanging over the stove top.
- Recommend having a working fire extinguisher in the home and knowing how to use it.

need to assess an elderly patient's ability to safely perform activities of daily living, assist elderly patients and families to modify their environment to ensure safety, and make referrals as needed.

Outlook for Survival and Recovery

The National Center for Injury Prevention and Control of the Centers for Disease Control and Prevention (CDC) identifies fire or burn injury as the fifth most common cause of death from unintentional injury in the United States and the third leading cause of death in the home from injury (CDC, 2008).

Great strides in research have helped to increase the survival rate of patients with burn injuries. Mortality has fallen to levels never thought possible. Long-term outcomes can now be explored because patients with very large burns are surviving their injuries. Research in areas such as fluid resuscitation, emergency burn treatment, inhalation injury and management, nutritional needs and changes in wound care practice with early excision, skin grafting, and use of skin substitutes have contributed greatly to the decrease in burn deaths. Continued research and advances in the areas of critical care, rehabilitation, psychosocial, and scar management are essential for continued progress in burn care.

Severity

The severity of each burn injury is determined by multiple factors that when assessed help the burn team estimate the likelihood that a patient will survive and plan for the care for each patient. These factors include age of the patient; depth of the burn; amount of surface area of the body that is burned; the presence of inhalation injury; presence of other injuries; location of the injury in special care areas such as the face, the perineum, hands, or feet; and the presence of a past medical history.

Age

Young children and the elderly continue to have increased morbidity and mortality when compared to other age groups with similar injuries and present a challenge for burn care. This is an important factor when determining the severity of injury and possible outcome for the patient.

Burn Depth

Burns are classified according to the depth of tissue destruction as superficial partial-thickness injuries, deep partial-thickness injuries, or full-thickness injuries (Table 57-1). These three categories are similar to, but not the same as, first-, second-, and third-degree burn classifications. Although the term fourth-degree burn is not used universally, it occurs with prolonged flame contact or high-voltage injury that destroys all layers of the skin and damages tendons and muscles.

In a superficial partial-thickness burn, the epidermis is destroyed or injured and a portion of the dermis may be injured. A deep partial-thickness burn involves destruction of the epidermis and upper layers of the dermis and injury to deeper portions of the dermis. Capillary refill follows tissue blanching. Hair follicles remain intact. A full-thickness burn involves total destruction of epidermis and dermis and, in some cases, destruction of underlying tissue, muscle, and bone. Wound color ranges widely from pale white to red, brown, or charred black. The burned area is painless and lacks sensation because nerve fibers are destroyed. The wound appears leathery; hair follicles and sweat glands are destroyed (Fig. 57-1). The severity of this burn is often deceiving to patients because they have no pain in the injury area. These wounds require skin grafting for healing.

Burn depth determines whether epithelialization will occur. Determining burn depth can be difficult even for the experienced burn care provider. The following factors are

Table 57-1 CHARACTERISTICS OF BURNS ACCORDING TO DEPTH

Depth of Burn and Causes	Skin Involvement	Symptoms	Wound Appearance	Recuperative Course
Superficial Partial-Thickness (Similar to First Degree)				
Sunburn Low-intensity flash	Epidermis; possibly a portion of dermis	Tingling Hyperesthesia (supersensitivity) Pain that is soothed by cooling	Reddened; blanches with pressure; dry Minimal or no edema Possible blisters	Complete recovery within a week; no scarring Peeling
Deep Partial-Thickness (Similar to Second Degree)				
Scalds Flash flame Contact	Epidermis, upper dermis, portion of deeper dermis	Pain Hyperesthesia Sensitive to cold air	Blistered, mottled red base; broken epidermis; weeping surface Edema	Recovery in 2 to 4 weeks Some scarring and depigmentation contractures Infection may convert it to full thickness
Full-Thickness (Similar to Third Degree)				
Flame Prolonged exposure to hot liquids Electric current Chemical Contact	Epidermis, entire dermis, and sometimes subcutaneous tissue; may involve connective tissue, muscle, and bone	Pain free Shock Hematuria (blood in the urine) and possibly hemolysis (blood cell destruction) Possible entrance and exit wounds (electrical burn)	Dry; pale white, leathery, or charred Broken skin with fat exposed Edema	Eschar sloughs Grafting necessary Scarring and loss of contour and function; contractures Loss of digits or extremity possible

Figure 57-1 Full-thickness injury to chest and upper extremity. Epidermis, varying levels of the dermis and subcutaneous tissue is injured. Used with permission. Lehigh Valley Health Network, Allentown, PA.

considered in determining the depth of a burn: how the injury occurred, causative agent (such as flame or scalding liquid), temperature of the burning agent, duration of contact with the agent, and thickness of the skin.

Extent of Body Surface Area Injured

Various methods are used to estimate the TBSA affected by burns; among them are the rule of nines, the Lund and Browder method, and the palmer method. These methods assist the burn team in making decisions about treatment and transfer of the patient to a burn center.

Rule of Nines

A common method, the **rule of nines** (Fig. 57-2), is a quick way to estimate the extent of burns in adults. The system divides the body into multiples of nine. The sum total of these parts equals the total body surface area and is an important measurement in the severity of injury (Shukla & Sheridan, 2008).

Lund and Browder Method

A more precise method of estimating the extent of a burn is the Lund and Browder method, which recognizes the percentage of surface area of various anatomic parts, especially the head and legs, as it relates to the age of the patient. By dividing the body into very small areas and providing an estimate of the proportion of TBSA accounted for by each body part, one can obtain a reliable estimate of TBSA burned. The initial evaluation is made on arrival of the patient at the hospital and is revised within the first 72 hours because demarcation of the wound and its depth presents itself more clearly by this time.

Palmer Method

In patients with scattered burns, or for a quick prehospital assessment, the palmer method may be used to estimate the extent of the burns. The size of the patient's palm, not including the surface area of the digits, is approximately 1% of the TBSA. The patient's palm without the fingers is equivalent to 0.5% TBSA and serves as a general measurement for all age groups (Shukla & Sheridan, 2008).

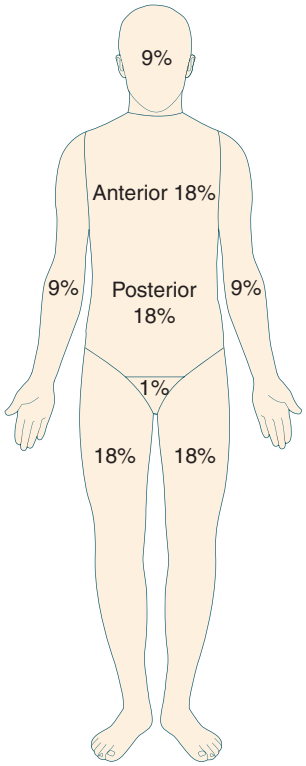

Figure 57-2 The rule of nines: Estimated percentage of total body surface area (TBSA) in the adult is arrived at by sectioning the body surface into areas with a numerical value related to nine. (Note: The anterior and posterior head total 9% of TBSA.)

Pathophysiology

Burn injury is a result of heat transfer from one site to another. Tissue destruction results from coagulation, protein denaturation, or ionization of cellular contents (Fig. 57-3). The skin and the mucosa of the upper airways are sites of tissue destruction. Deep tissues, including the viscera, can be damaged by electrical burns (Chart 57-2) or by prolonged contact with a heat source. Disruption of the skin can lead to increased fluid loss, infection, hypothermia, scarring, compromised immunity, and changes in function, appearance, and body image.

The depth of the injury depends on the temperature of the burning agent and the duration of contact with the agent. For example, in the case of scald burns in adults, 1 second of contact with hot tap water at 68.9°C (156°F) may result in a burn that destroys both the epidermis and the dermis, causing a full-thickness (third-degree) injury. Fifteen seconds of exposure to hot water at 56.1°C (133°F) results in a similar full-thickness injury. Temperatures less than 44°C (111°F) can be tolerated for long periods without injury.

Burns that do not exceed 20% TBSA produce a primarily local response. Burns that exceed 20% TBSA may produce both a local and a systemic response and are considered major burn injuries. The systemic response is caused by

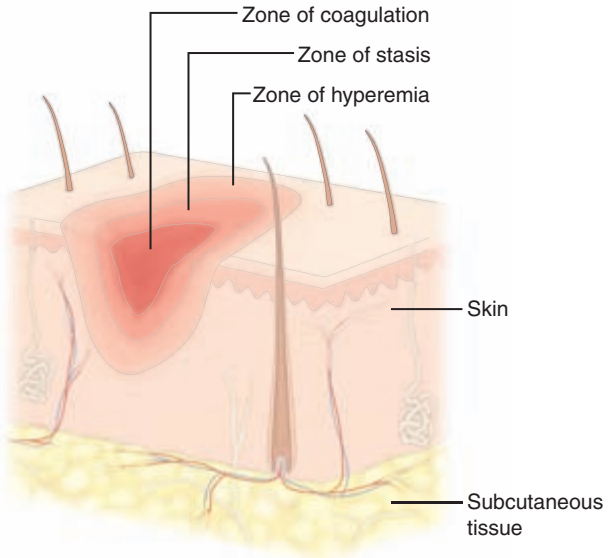

Figure 57-3 Zones of burn injury. Each burned area has three zones of injury. The inner zone (known as the area of coagulation, where cellular death occurs) sustains the most damage. The middle area, or zone of stasis, has a compromised blood supply, inflammation, and tissue injury. The outer zone—the zone of hyperemia—sustains the least damage.

the release of cytokines and other mediators into the systemic circulation. The release of local mediators and changes in blood flow, tissue edema, and infection can cause progression of the burn injury.

Pathophysiologic changes resulting from major burns during the initial burn-shock period include tissue hypoperfusion and organ hypofunction secondary to decreased cardiac output, followed by hyperdynamic and hypermetabolic phases. The incidence, magnitude, and duration of pathophysiologic changes in burns are proportional to the extent of burn injury, with a maximal response seen in burns covering 60% or more TBSA.

The initial systemic event after a major burn injury is hemodynamic instability, which results from loss of capillary integrity and a subsequent shift of fluid, sodium, and protein from the intravascular space into the interstitial spaces. Hemodynamic instability involves cardiovascular, fluid and electrolyte, blood volume, pulmonary, and other mechanisms.

Cardiovascular Alterations

Hypovolemia is the immediate consequence of fluid loss and results in decreased perfusion and oxygen delivery. Cardiac output decreases before any significant change in blood volume is evident. As fluid loss continues and vascular

Chart 57-2 • *Electrical Burns*

Electrical injury accounts for a small percentage of burn unit admissions each year, yet it is one of the most destructive types of burn injuries that can be sustained. The devastating effects of an electrical injury can cause lifelong neurovascular problems. Low-voltage injury (ie, less than 500 V exposure) generally does not cause significant damage or medical problems. Midrange exposure (ie, 200–1000 V) can cause local destruction to the tissue. High-voltage exposure (ie, greater than 1000 V) can cause loss of consciousness, fractures, compartment syndrome, arrhythmias, and is often associated with falls (Shukla & Sheridan, 2008).

Tissue and bone destruction often results in amputations and possible loss of life as the result of cardiac and respiratory abnormalities. A true electrical injury results when a current of electricity travels through the body and exits to the ground, causing internal damage to tissue and organs. Such an injury results in an entrance wound, which is the patient's point of contact with the source. The exit wound has a blow-out appearance, causing extensive damage to the surrounding tissue and structures. The amount of damage depends on the strength of the current and the length of the duration of contact with the source. An arc injury is the result of the electricity's traveling on the outside of the body or arcing around it. There is usually also a thermal injury due to clothing catching on fire. The surface injury from an electrical source is usually small compared with the damage under the surface of the skin. Electricity travels through areas of least resistance, nerves and blood vessels, to the most resistant, bone. The most severe damage occurs beneath the skin surface and is difficult to determine without surgical intervention (Shukla & Sheridan, 2008).

Once the patient is out of the path of the electricity, emergency care can safely be provided. The ABCs of emergency care are always followed. An electrical current immediately contracts muscles as it travels through the body, and cardiac dysrhythmias and spinal injuries often result from the muscular contraction. Cardiac dysrhythmias can occur in both low-voltage and high-voltage injury and therefore require electrocardiogram evaluation and monitoring. Those patients with loss of consciousness, dysrhythmias, or ST changes on ECG must be admitted and cardiac monitoring should occur (Arnoldo, Klein & Gibran, 2006). Until it is known that the patient has no fractures, it is imperative that a neck collar remain in place and that the patient is log-rolled to eliminate the chance of further spinal cord injury. With high-voltage electrical injuries, cervical spine immobilization is a priority until cervical spine injury is ruled out.

Prompt administration of intravenous (IV) fluids and monitoring of urine output are critical components of care. Patients with electrical burns are prone to acute renal failure because of the release of myoglobin resulting from the destruction of muscle and tissue. Myoglobin can constrict renal arteries and block urine flow through the kidneys. Patients can have gross hematuria on admission to the hospital. Administration of large amounts of IV fluids helps maintain the flow of urine. It is difficult to assess the amount of fluid a patient will require because the electrical injury creates such extensive internal damage. The nurse should expect 75 to 100 mL/h of urine output for a patient who is receiving fluid resuscitation. Creatine kinase (CK) is released by damaged muscle cells and it is measured during the early phases of care to assist in determining the degree of muscle injury.

In patients with electrical injuries, neurovascular checks of affected extremities are very important. Assessment of color, temperature, and sensation in the extremity as well as the monitoring of palpable or Doppler pulses should be done to assess adequate blood flow to the extremity. If indicated by clinical assessment, the measurement of compartment syndrome to determine deep tissue injury can be performed. Compartment pressures greater than 30 mm Hg can indicate poor tissue perfusion and the need for surgical decompression (Arnoldo, et al., 2006).

volume decreases, cardiac output continues to decrease and the blood pressure drops. This is the onset of burn shock. In response, the sympathetic nervous system releases catecholamines, resulting in an increase in peripheral resistance (vasoconstriction) and an increase in pulse rate. Peripheral vasoconstriction further decreases cardiac output.

Prompt fluid resuscitation maintains the blood pressure in the low to normal range and improves cardiac output. Despite adequate fluid resuscitation, cardiac filling pressures (central venous pressure, pulmonary artery pressure, and pulmonary artery wedge pressure) remain low during the burn-shock period. If inadequate fluid resuscitation occurs, distributive shock occurs (see Chapter 15).

Generally the greatest volume of fluid leak occurs in the first 24 to 36 hours after the burn, peaking by 6 to 8 hours. As the capillaries begin to regain their integrity, burn shock resolves and fluid returns to the vascular compartment. As fluid is reabsorbed from the interstitial tissue into the vascular compartment, blood volume increases. If renal and cardiac function is adequate, urinary output increases. Diuresis continues for several days to 2 weeks.

At the time of burn injury, some red blood cells may be destroyed and others damaged, resulting in anemia. Despite this, the hematocrit may be elevated due to plasma loss. Blood losses sustained during surgical procedures, wound care, and diagnostic studies and ongoing hemolysis further contribute to anemia. Blood transfusions are required periodically to maintain adequate hemoglobin levels for oxygen delivery. Abnormalities in coagulation, including a decrease in platelets (thrombocytopenia) and prolonged clotting and prothrombin times, also occur with burn injury.

Fluid and Electrolyte Alterations

Edema forms rapidly after a burn injury. A superficial burn will cause edema to form within 4 hours after injury, while a deeper burn will continue to form over a longer period of time up to 18 hours postinjury. This is caused by increased perfusion to the injured area and is reflective of the amount of vascular and lymphatic damage to the tissue. There is loss of capillary integrity, and fluid is localized to the burn itself, resulting in blister formation and edema only in the area of injury. Patients with more severe burns develop massive systemic edema (Greenhalgh, 2007). Reabsorption begins at about 4 hours and is complete by 4 days postburn injury. However, the reabsorption is dependent on the depth of injury to the tissue. Partial-thickness injury resolves more quickly due to a more functioning lymphatic system and increased perfusion when compared to the full-thickness injury (Greenhalgh, 2007). Edema in burn wounds can be reduced by avoiding excessive fluid administration during the early postburn period. Excessive fluid administration increases edema formation in both burned and nonburned tissue.

As the taut, burned tissue becomes unyielding to the edema underneath its surface, it begins to act like a tourniquet, especially if the burn is circumferential. As edema increases, pressure on small blood vessels and nerves in the distal extremities causes an obstruction of blood flow and consequent ischemia. This complication is similar to a compartment syndrome. The physician may need to perform an **escharotomy,** a surgical incision into the **eschar** (devitalized tissue resulting from a burn) to relieve the constricting effect of the burned tissue (Demling, 2005a).

Circulating blood volume decreases dramatically during burn shock. In addition, evaporative fluid loss through the burn wound may reach 3 to 5 L or more over a 24-hour period until the burn surfaces are covered.

During burn shock, serum sodium levels vary in response to fluid resuscitation. Usually, hyponatremia (sodium depletion) is present. Hyponatremia is also common during the first week of the acute phase, as water shifts from the interstitial space to the vascular space.

Immediately after burn injury, hyperkalemia (excessive potassium) results from massive cell destruction. Hypokalemia (potassium depletion) may occur later with fluid shifts and inadequate potassium replacement.

Pulmonary Alterations

Approximately 10% to 20% of patients admitted to burn centers have an inhalation injury. The presence of this injury increases the hospital length of stay, is a determinant of the severity of injury, and increases mortality and morbidity (Palmieri, 2007). An inhalation injury occurs when a person is trapped inside a burning structure or involved in an explosion that leads to the inhalation of superheated air and noxious gas (McCall & Cahill, 2005).

Deterioration in severely burned patients can occur without obvious evidence of a smoke inhalation injury. Bronchoconstriction (caused by release of histamine, serotonin, and thromboxane, a powerful vasoconstrictor) and chest constriction secondary to circumferential full-thickness chest burns cause this deterioration. Even without pulmonary injury, hypoxia (oxygen starvation) may be present. Early in the postburn period, catecholamine release in response to the stress of the burn injury alters peripheral blood flow, thereby reducing oxygen delivery to the periphery. Later, hypermetabolism and continued catecholamine release lead to increased tissue oxygen consumption, which can lead to hypoxia. To ensure that adequate oxygen is available to the tissues, supplemental oxygen may be needed.

Pulmonary injuries are categorized as upper airway injury or inhalation injury below the glottis. Upper airway injury results from inhalation of direct heat greater then 150°C (302°F) to the epithelium. This damage results in severe upper airway edema, which can cause obstruction of the upper airway, including the pharynx and larynx, in the early hours postburn (Palmieri, 2007). Because of the cooling effect of rapid vaporization in the pulmonary tract, direct heat injury does not normally occur below the level of the bronchus. Upper airway injury is treated by early nasotracheal or endotracheal intubation.

Inhalation injury below the glottis results from inhaling the products of incomplete combustion or noxious gases. Inhalation of noxious gases is often the source of death at the scene of a fire. These products include carbon monoxide, cyanide, ammonia, aldehydes, acrolein, sulfur dioxide, and isocyanates (Barillo, 2009; Kealey, 2009; Palmieri, 2007). Tissue hypoxia is the result of carbon monoxide inhalation. It combines with hemoglobin to form **carboxyhemoglobin.** The affinity of hemoglobin for carbon monoxide is 250 times greater than that for oxygen. This injury results

directly from chemical irritation of the pulmonary tissues at the alveolar level. Inhalation injuries below the glottis cause loss of ciliary action, hypersecretion, severe mucosal edema, and possibly bronchospasm. The pulmonary surfactant is reduced, resulting in atelectasis (collapse of alveoli). Expectoration of carbon particles in the sputum is the cardinal sign of this injury.

Treatment usually consists of early intubation and mechanical ventilation with 100% oxygen, which reduces the half-life of carboxyhemoglobin from 4 hours to 45 minutes (Kealey, 2009; Pham & Gibran, 2007). However, some patients require only oxygen therapy, depending on the extent of pulmonary injury and edema.

Restrictive pulmonary excursion may occur with full-thickness burns encircling the neck and thorax. Chest excursion may be greatly restricted, resulting in decreased tidal volume. In such situations, escharotomy is necessary.

Pulmonary abnormalities are not always immediately apparent. More than half of all patients with burn injuries with pulmonary involvement do not initially demonstrate pulmonary signs and symptoms. Any patient with possible inhalation injury must be observed for at least 24 hours for respiratory complications. Airway obstruction may occur very rapidly or develop in hours, even while fluid resuscitation is under way. Decreased lung compliance, decreased arterial oxygen levels, and respiratory acidosis may occur gradually over the first 5 days after a burn.

Indicators of possible upper airway injury include (1) injury occurring in an enclosed space; (2) burns of the face or neck; (3) singed nasal hair; (4) hoarseness, high-pitched voice change, dry cough, stridor; (5) sooty or bloody sputum; (6) labored breathing or tachypnea (rapid breathing) and other signs of reduced oxygen levels (hypoxemia); and (7) erythema and blistering of the oral or pharyngeal mucosa.

Diagnosis of lower airway inhalation injury includes monitoring of arterial blood gases and carboxyhemoglobin levels and direct observation of the airway by fiberoptic bronchoscopy to confirm the clinical diagnosis. Findings on bronchoscopy include airway edema, inflammation, necrosis, and soot in the airway (Edelman, White, Tyburski, et al., 2006). Less frequently, xenon scan and computed tomography scans can be used to aid diagnosis but are of questionable value (Pham & Gibran, 2007).

Pulmonary complications secondary to inhalation injuries include sloughing of the airway, increased secretions and inflammation, atelectasis, airway obstruction and ulceration, pulmonary edema, and tissue hypoxia. As a result, respiratory failure and acute respiratory distress syndrome (ARDS) and pneumonia can develop (Edelman, et al., 2006). Respiratory failure and ARDS are discussed in Chapter 23.

Renal Alterations

Renal function may be altered as a result of decreased blood volume. Destruction of red blood cells at the injury site results in free hemoglobin in the urine. If muscle damage occurs (eg, from electrical burns), myoglobin is released from the muscle cells and excreted by the kidneys. Adequate fluid volume replacement restores renal blood flow, increasing the glomerular filtration rate and urine volume. If there is inadequate blood flow through the kidneys, the hemoglobin and myoglobin occlude the renal tubules, resulting in acute tubular necrosis and renal failure (see Chapter 44).

Immunologic Alterations

The immunologic defenses of the body are greatly altered by a burn injury. Patients with burn injury are at high risk for infection and sepsis. The skin is the largest barrier to infection, and when it is compromised, the patient is continually exposed to the environment. The loss of skin integrity is compounded by the release of abnormal inflammatory factors, altered levels of immunoglobulins and serum complement, impaired neutrophil function, and a reduction in lymphocytes (lymphocytopenia). These alterations result in immunosuppression and increase the risk for sepsis. As a result, the major cause of death in the burn patient who survives after 24 hours is multiple organ dysfunction syndrome (MODS) (Greenhalgh, 2007). Most burn centers are specifically designed to provide an infection-controlled environment to protect the patient and minimize exposure to potentially harmful organisms.

Thermoregulatory Alterations

Loss of skin also results in an inability to regulate body temperature. Patients with burn injuries may therefore exhibit low body temperatures in the early hours after injury. Then, as hypermetabolism resets core temperature, the patient becomes hypothermic for much of the postburn period, even in the absence of infection. Most burn centers have heat panels at the bedside and additional heating sources to help maintain the patient's body temperature.

Gastrointestinal Alterations

Two potential gastrointestinal (GI) complications may occur: paralytic ileus (absence of intestinal peristalsis) and Curling's ulcer. Decreased peristalsis and bowel sounds are manifestations of paralytic ileus resulting from burn trauma. Gastric distention and nausea may lead to vomiting unless gastric decompression is initiated. Gastric bleeding secondary to massive physiologic stress may be signaled by occult blood in the stool, regurgitation of "coffee ground" material from the stomach, or bloody vomitus. These signs suggest gastric or duodenal erosion (Curling's ulcer).

Other alterations affect the GI tract after burn injury: the mucosal barrier becomes permeable, the permeability allows for overgrowth of GI bacteria, and the bacteria translocate to other organs, causing infection. Patients are unable to defend against their own bacteria due to immunosuppression. In addition, alcohol ingestion, which is common in the burn population, affects GI integrity and immune response, further increasing the risk of infection and possible bleeding complications (Gosain & Gamelli, 2005a).

Patients with large TBSA burns are also at risk for abdominal compartment syndrome (ACS). During resuscitation, fluid shifts into the abdominal cavity, causing increased abdominal distention, decreased urine output, hypotension, and respiratory insufficiency. The development of ACS is related to the volume of fluids administered. Factors such as the presence of inhalation injury, deep thermal injury, glucosuria, delayed or inadequate

resuscitation, and hemoglobinuria may necessitate additional fluids that may not be calculated by formulas. Bladder pressure is measured to determine the need for invasive intervention to treat increasing abdominal pressure. Bladder pressures greater than 25 mm Hg over time indicate increasing abdominal pressure. Although the prevention of this complication is not always possible, cautious and continuous measurement of fluids administered and urine output is essential (Hershberger, Hunt, Arnoldo, et al., 2007).

Management of Burn Injury

Burn care is typically categorized into three phases of care: emergent/resuscitative phase, acute/intermediate phase, and rehabilitation phase. Although priorities exist for each of the phases, the phases overlap, assessment, and management of specific problems and complications are not limited to these phases but take place throughout burn care. The three phases and the priorities for care are summarized in Table 57-2.

EMERGENT/RESUSCITATIVE PHASE

On-the-Scene Care

Preventing injury to the rescuer is the first priority of on-the-scene care. If needed, fire and emergency medical services should be requested at the first opportunity. Usually, rescue workers cover the wound, establish an airway, supply oxygen, and insert at least one large-bore intravenous (IV) line. Chart 57-3 describes the procedures and care required at the burn scene.

The burned person's appearance can be frightening at first. Although the local effects of a burn are the most evident, the systemic effects pose greater threats to life. A primary survey of the patient is carried out to assess the *a*irway (A), gas exchange or *b*reathing (B), and *c*irculatory status (C) as well as the need for cervical spine immobilization and cardiac monitoring for patients with high-voltage electrical injuries. The circulatory system must be assessed quickly. Apical pulse and blood pressure are monitored frequently. Tachycardia (abnormally rapid heart rate) and slight hypotension are expected soon after the burn. In the patient with extensive burns, neurologic status is assessed quickly. Often the patient is awake and alert initially, and vital information can be obtained at that time.

NURSING ALERT

Breathing must be assessed and a patent airway established immediately during the initial minutes of emergency care. Immediate therapy is directed toward establishing an airway and administering humidified 100% oxygen. If such a high concentration of oxygen is not available under emergency conditions, oxygen by mask or nasal cannula is given initially. If qualified personnel and equipment are available and the victim has severe respiratory distress or airway edema, the rescuers can insert an endotracheal tube and initiate manual ventilation.

NURSING ALERT

No food or fluid is given by mouth, and the patient is placed in a position that will prevent aspiration of vomitus, because nausea and vomiting typically occur due to paralytic ileus resulting from the stress of injury.

The secondary survey focuses on the completion of the total body system assessment, including the mechanism of injury, inhalation injury, and presence of corneal injury. A secondary head-to-toe survey of the patient is carried out to identify other potentially life-threatening injuries (Shukla & Sheridan, 2008).

Medical Management

The patient is transported to the nearest emergency department (ED). The hospital and physician are alerted that the patient is en route so that life-saving measures can be initiated immediately by a trained team and plans for referral to a burn center can be made.

Initial priorities in the ED remain airway, breathing, and circulation. For mild pulmonary injury, 100% humidified

Table 57-2 PHASES OF BURN CARE

Phase	Duration	Priorities
Emergent/resuscitative	From onset of injury to completion of fluid resuscitation	• First aid • Prevention of shock • Prevention of respiratory distress • Detection and treatment of concomitant injuries • Wound assessment and initial care
Acute/intermediate	From beginning of diuresis to near completion of wound closure	• Wound care and closure • Prevention or treatment of complications, including infection • Nutritional support
Rehabilitation	From major wound closure to return to individual's optimal level of physical and psychosocial adjustment	• Prevention of scars and contractures • Physical, occupational, and vocational rehabilitation • Functional and cosmetic reconstruction • Psychosocial counseling

Chart 57-3 • *Emergency Procedures at the Burn Scene*

- **Extinguish the flames.** When clothes catch fire, the flames can be extinguished if the person falls to the floor or ground and rolls ("stop, drop, and roll"); anything available to smother the flames, such as a blanket, rug, or coat, may be used. Standing still forces the person to breathe flames and smoke, and running fans the flames. If the burn source is electrical, the electrical source must be disconnected safely.
- **Cool the burn.** After the flames are extinguished, the burned area and adherent clothing are soaked with *cool* water, briefly, to cool the wound and halt the burning process. Once a burn has been sustained, the application of cool water is the best first-aid measure. However, *never* apply ice directly to the burn, *never* wrap the person in ice, and *never* use cold soaks or dressings for longer than several minutes; such procedures may worsen the tissue damage and lead to hypothermia in people with large burns.
- **Remove restrictive objects.** If possible, remove clothing immediately. Adherent clothing may be left in place once cooled. Other clothing and all jewelry, including all piercings, should be removed to allow for assessment and to prevent constriction secondary to rapidly developing edema.
- **Cover the wound.** The burn should be covered as quickly as possible to minimize bacterial contamination, to maintain body temperature, and decrease pain by preventing air from coming in contact with the injured surface. Sterile dressings are best, but any clean, dry cloth can be used as an emergency dressing. Ointments and salves should *not* be used. Other than the dressing, no medication or material should be applied to the burn wound.
- **Irrigate chemical burns.** Chemical burns resulting from contact with a corrosive material are irrigated immediately. Most chemical laboratories have a high-pressure shower for such emergencies. If such an injury occurs at home, brush off the chemical agent, remove clothes immediately, and rinse all areas of the body that have come in contact with the chemical. Rinsing can occur in the shower or any other source of continuous running water. If a chemical gets in or near the eyes, the eyes should be flushed with cool, clean water immediately. Outcomes for the patient with chemical burns are significantly improved by rapid, sustained flushing of the injury at the scene.

oxygen is administered and the patient is encouraged to cough so that secretions can be removed by suctioning. For more severe situations, it is necessary to remove secretions by bronchial suctioning and to administer bronchodilators and mucolytic agents. If edema of the airway develops, endotracheal intubation may be necessary. Continuous positive airway pressure and mechanical ventilation may also be required to achieve adequate oxygenation.

After adequate respiratory function and circulatory status have been established, the patient is assessed for cervical spinal injuries or head injury if he or she was involved in an explosion, a fall, a jump, or an electrical injury. Once the patient's condition is stable, attention is directed to the burn wound itself. All clothing and jewelry are removed. For chemical burns, flushing of the exposed areas is continued. The patient is checked for contact lenses. These are removed immediately if chemicals have contacted the eyes or if facial burns have occurred.

It is important to validate an account of the burn scenario provided by the patient, witnesses at the scene, and paramedics. Information needs to include the time of the burn injury, the source of the burn, the place where the burn occurred, how long the patient was in the burning structure, how the burn was treated at the scene, and any history of falling or jumping at the scene. A history of preexisting diseases, allergies, medications, and the use of drugs, alcohol, and tobacco is obtained at this point to aid in planning the patient's care. A large-bore (16- or 18-gauge) IV catheter should be inserted in a nonburned area (if not inserted earlier). Most patients will have a central venous catheter inserted so that large amounts of IV fluids can be administered quickly and central venous pressures can be monitored.

If the burn exceeds 20% to 25% TBSA, a nasogastric tube is inserted and connected to low intermittent suction. Often, patients with large burns become nauseated as a result of the GI effects of the burn injury, such as paralytic ileus, and the effects of medication, such as opioids. All patients who are intubated should have a nasogastric tube inserted to decompress the stomach and prevent vomiting.

The physician evaluates the patient's general condition, assesses the burn, determines the priorities of care, and directs the individualized plan of treatment, which is divided into systemic management and local care of the burned area. Nonsterile gloves, caps, masks and cover gowns are worn by personnel while assessing the exposed burned areas. Clean technique is maintained while assessing and treating the burn wounds.

Assessment of both the TBSA burned and the depth of the burn are completed after soot and debris have been gently cleansed from the burn wound. Careful attention is paid to keeping the patient warm during wound assessment and cleansing. Assessment is repeated frequently throughout burn wound care. Photographs may be taken of the burn areas initially and periodically throughout treatment; in this way, the initial injury and burn wound can be documented. Such documentation is invaluable for insurance and legal claims.

Clean sheets are placed under and over the patient to protect the burn wound from contamination, maintain body temperature, and reduce pain caused by air currents passing over exposed nerve endings. An indwelling urinary catheter is inserted to permit more accurate monitoring of urine output and renal function for patients with moderate to severe burns. Baseline height, weight, arterial blood gases, hematocrit, electrolyte values, blood alcohol level, drug panel, urinalysis, and chest x-rays are obtained. If the patient is elderly or has an electrical burn, a baseline electrocardiogram (ECG) is obtained. Because burns are contaminated wounds, tetanus prophylaxis is administered if

the patient's immunization status is not current or is unknown.

NURSING ALERT

If necessary, a blood pressure cuff can be placed around a patient's burned extremity. The cuff must be of the correct size with accommodations made for bulky dressings.

Although the major focus of care during the emergent phase is physical stabilization, the nurse must also attend to the patient's and family's psychological needs. Burn injury is a crisis, one that causes varying emotional responses. The patient's and family's coping abilities and available supports are assessed. Circumstances surrounding the burn injury should be considered when providing care. Individualized psychosocial support must be given to the patient and family. Because the patient is usually anxious and in pain, nurses should provide reassurance and support, explanations of procedures, and adequate pain relief. Because poor tissue perfusion accompanies burn injuries, only IV analgesia (usually morphine) is administered, titrated for the individual patient. If the patient wishes to see a spiritual advisor or counselor, one is notified.

Transfer to a Burn Center

Patients with the following types of injuries are referred to a burn center for evaluation and care: burns with partial-thickness injury greater than 10% or full-thickness burns in any age group; a burn in an area of the body that requires special attention, such as the face, hands, feet, genitalia, perineum, and over joints; and chemical, electrical, or inhalation burns. Patients with preexisting medical problems or who may have additional trauma that could complicate care should be referred. Children with burns are transferred if they cannot be managed by the available pediatric team. Lastly, any burn injury that carries special social, emotional, or rehabilitative need should be referred to a burn center where these needs are addressed more readily (Guidelines for the Operation of Burn Centers, 2007).

If the patient is to be transported to a burn center, the following measures, listed in order of importance, are instituted before transfer:

- A patent airway is ensured.
- Adequate peripheral circulation is established in any burned extremity.
- A secure IV catheter is inserted with lactated Ringer's solution infusing at the rate required to maintain a urine output of at least 30 mL per hour.
- An indwelling urinary catheter is inserted.
- Adequate pain relief is attained.
- Wounds are covered with a clean, dry sheet, and the patient is kept comfortably warm.

All assessments and treatments are documented, and this information is provided to the burn center personnel. The transferring facility must relay accurate vital signs, temperature, and intake and output totals to burn center personnel so that adequate fluid resuscitation measures will continue.

Management of Fluid Loss and Shock

Next to managing respiratory difficulties, the most urgent need is preventing irreversible shock by replacing lost fluids and electrolytes. As stated previously, survival of the patient with burn injury depends on adequate fluid resuscitation. Table 57-3 describes the fluid changes that occur in the emergent/resuscitative phase of care. Baseline weight and laboratory test results are obtained, and these parameters must be monitored closely in the immediate postburn (resuscitation) period. Both underresuscitation and overresuscitation are associated with poor outcome, and the optimal formula has not been identified; however, regardless of rate and composition of the fluids and colloids administered, diligent monitoring through the first 72 hours is critical to ensure optimal management (Pham, Cancio & Gilbran, 2008).

Fluid Replacement Therapy

The total volume and rate of IV fluid replacement are gauged by the patient's response and guided by the resuscitation formula. The adequacy of fluid resuscitation is determined by monitoring urine output totals, an index of renal

Table 57-3 FLUID AND ELECTROLYTE CHANGES IN THE EMERGENT/RESUSCITATIVE PHASE

Fluid accumulation phase (shock phase)
Plasma → interstitial fluid (edema at burn site)

Observation	Explanation
Generalized dehydration	Plasma leaks through damaged capillaries
Reduction of blood volume	Secondary to plasma loss, fall of blood pressure, and diminished cardiac output
Decreased urinary output	Secondary to: Fluid loss Decreased renal blood flow Sodium and water retention caused by increased adrenocortical activity Hemolysis of red blood cells, causing hemoglobinuria and myonecrosis or myoglobinuria
Potassium (K^+) excess	Massive cellular trauma causes release of K^+ into extracellular fluid (ordinarily, most K^+ is intracellular)
Sodium (Na^+) deficit	Large amount of Na^+ is lost in trapped edema fluid and exudate and by shift into cells as K^+ is released from cells (ordinarily most Na^+ is extracellular)
Metabolic acidosis (base-bicarbonate deficit)	Loss of bicarbonate ions accompanies sodium loss
Hemoconcentration (elevated hematocrit)	Liquid blood component is lost into extravascular space

perfusion. Urine output totals of 0.5 to 1.0 mL/kg/h for adults have been used as resuscitation goals (Pham, et al., 2008).

NURSING ALERT

Clinical parameters are far more important in resuscitation than any formula. Indeed, the patient's individual response is the key to assessing the adequacy of fluid resuscitation.

Additional gauges of fluid requirements and response to fluid resuscitation include hematocrit and hemoglobin and serum sodium levels. Within the first 24 hours after injury, if the hematocrit and the hemoglobin levels decrease or if the urinary output exceeds 50 mL/h, the rate of IV fluid administration may be decreased. One goal is to maintain serum sodium levels in the normal range during fluid replacement.

Appropriate resuscitation endpoints for patients with burn injuries remain unresolved, although some studies have examined hemodynamic and oxygen transport as resuscitation endpoints. Successful resuscitation is associated with increased delivery of oxygen and consumption of oxygen with declining serum lactate levels (Demling, 2005a). Factors associated with increased fluid requirements include delayed resuscitation, full-thickness injury, and presence of inhalation injuries. A State-of-the-Science in Burn Care conference was held in 2006 to identify the focus of research in the next decade. Overresuscitation was identified as a high-priority topic along with a need to identify endpoints for resuscitation (Pham, et al., 2008).

Fluid Requirements

The projected fluid requirements for the first 24 hours are calculated by the clinician based on the extent of the burn injury. Some combination of fluid categories may be used, including colloids (whole blood, plasma, and plasma expanders) and crystalloids/electrolytes (physiologic sodium chloride or lactated Ringer's solution). Adequate fluid resuscitation results in slightly decreased blood volume levels during the first 24 postburn hours and restoration of plasma levels to normal by the end of 48 hours. Formulas have been developed for estimating fluid loss based on the estimated percentage of burned TBSA and the weight of the patient. TBSA greater than 20% to 25% is associated with increased capillary permeability and intravascular fluid shifts that are most profound in the first 24 hours postburn (Pham, et al., 2008).

Oral and enteral resuscitation can be successful in adults with less than 20% TBSA burned (Atiyeh, Gunn & Hayek, 2005). Intravenous resuscitation is recommended when burn TBSA is greater then 20% (Pham, et al., 2008).

Although there is no consensus on the formulas for resuscitation, currently the most popular formula provides for the volume of an isotonic solution to be administered during the first 24 hours in a range of 2 to 4 mL/kg per percentage of TBSA burned. As with the other formulas, half of the calculated total should be given over the first 8 postburn hours, and the other half should be given over the next 16 hours. The hourly rate and volume of the infusion are modified based on the patient's response (Pham, et al., 2008). Clinicians should take note that the resuscitation formulas serve only as guidelines, and the patient's response to fluid therapy is the best parameter to use (Atiyeh, et al., 2005).

With large burns, there is a failure of the sodium–potassium pump (a physiologic mechanism involved in fluid–electrolyte balance) at the cellular level. Therefore, patients with very large burns may need proportionately more milliliters of fluid per percentage of burn than those with smaller burns. Also, patients with electrical injury, inhalation injury, or delayed fluid resuscitation and those who were burned while intoxicated may need additional fluids.

The following example illustrates the use of the consensus formula in a 70-kg (154-lb) patient with a 50% TBSA burn:

1. Formula: 2 to 4 mL/kg/% TBSA
2. 2 mL × 70 kg × 50 TBSA = 7000 mL/24 h
3. Plan to administer: first 8 hours = 3500 mL, or 437 mL/h; next 16 hours = 3500 mL, or 219 mL/h

Most fluid replacement formulas use isotonic electrolyte solutions. Regardless of which standard replacement formula is used, the patient receives approximately the same fluid volume and sodium replacement during the first 48 hours.

Another fluid replacement method requires hypertonic electrolyte solutions. The goal is to deliver smaller amounts of fluid and maintain the same urine output. Hypertonic resuscitation increases the osmolarity of the blood and encourages a shift of fluid into the intravascular space from the interstitial space. Careful monitoring of serum sodium level is required to prevent hypernatremia and acute renal failure (Pham, et al., 2008).

The use of colloids during resuscitation has been the subject of much controversy. Administration of large volumes of crystalloid during resuscitation decreases the protein content in the blood. Proteins help to prevent the movement of fluid and decrease edema. The purpose of adding colloid to the formula is to decrease the amount of fluid needed and also prevent massive edema formation. In contrast, some clinicians believe that after 24 hours the integrity of the capillaries begins to be restored and the use of colloids during that time would not be advantageous. These theories require further study (Pham, et al., 2008).

NURSING ALERT

Formulas are only a guide. The patient's response, evidenced by heart rate, blood pressure, and urine output, is the primary determinant of actual fluid therapy and must be assessed at least hourly. Patient outcomes are improved by optimal fluid resuscitation.

Nursing Management

Nursing assessment in the emergent phase of burn injury focuses on the major priorities for any trauma patient; the burn wound is a secondary consideration. Aseptic management of the burn wounds and invasive lines continues.

The nurse monitors vital signs frequently. Respiratory status is monitored closely, and apical, carotid, and femoral pulses are evaluated particularly in areas of circumferential burn injury to an extremity. Cardiac monitoring is indicated initially or if the patient has a history of cardiac disease, electrical injury, or respiratory conditions.

If all extremities are burned, determining blood pressure may be difficult. A sterile dressing applied under the blood pressure cuff protects the wound from contamination. Because increasing edema makes blood pressure difficult to auscultate, a Doppler (ultrasound) device or a noninvasive electronic blood pressure device may be helpful. In patients with severe burns, an arterial catheter is used for blood pressure measurement and for collecting blood specimens. Peripheral pulses of burned extremities are checked hourly; the Doppler device is useful for this. Elevation of burned upper extremities above the level of the heart is crucial to decrease edema. Elevation of the lower extremities on pillows and of the upper extremities on pillows or by suspension using IV poles may be helpful.

Large-bore IV catheters and an indwelling urinary catheter are inserted, if not already in place, and the nurse's assessment includes monitoring of fluid intake and output. Urine output, an indicator of renal perfusion, is monitored carefully and measured hourly. The amount of urine first obtained when the urinary catheter was inserted is recorded. This may assist in determining the extent of preburn renal function and fluid status.

Burgundy-colored urine suggests the presence of hemochromogen and myoglobin resulting from muscle damage. This is associated with deep burns caused by electrical injury or prolonged contact with flames. Glycosuria, a common finding in the early postburn hours, results from the release of stored glucose from the liver in response to stress.

Although not responsible for prescribing the fluids the nurse should be able to calculate the patient's expected fluid requirements. Infusion pumps are used to deliver a complex regimen of IV fluids prescribed. Administering and monitoring IV therapy are major nursing responsibilities. Strict monitoring of fluid intake and output is essential during the resuscitative phase along with reporting laboratory values and reporting patient responses to the physician.

Body temperature, body weight, preburn weight, and history of allergies, tetanus immunization, past medical and surgical disorders, current illnesses, and a list of current medications are essential to help guide medication needs for the patient. A head-to-toe assessment is performed, focusing on signs and symptoms of concomitant illness, associated injury, or developing complications. If the patient has facial burns, his or her eyes should be examined for injury to the corneas. An ophthalmologist is consulted for complete assessment via fluorescent staining.

Assessing the extent of the burn wound continues and is facilitated with anatomic diagrams (described previously). In addition, the nurse works with the physician to assess the depth of the wound and areas of full-thickness and partial-thickness injury. Assessment of the circumstances surrounding the injury is important. Obtaining a history of the burn injury can help in planning the care for the patient. Assessment should include the time of injury, mechanism of burn, whether the burn occurred in a closed space, the possibility of inhalation of noxious chemicals, and any related trauma. The neurologic assessment focuses on the patient's level of consciousness, psychological status, pain and anxiety levels, and behavior.

The patient's and family's understanding of the injury and treatment is assessed as well. A family meeting upon admission is helpful to explain the detail of the patient's injuries and the course of treatment. Ethical dilemmas, such as those discussed in Chart 57-4, may also occur during hospitalization.

Nursing care of the patient during the emergent/resuscitative phase of burn injury is detailed in the plan of nursing care in Chart 57-5.

Gerontologic Considerations

Comorbid conditions coupled with the burn injury contribute to the high mortality rates of patients 65 years and older. Demling (2005b) reported that more than 60% of elderly patients with burn injuries admitted to the hospital had moderate to severe protein–energy malnutrition, which contributed to an increase in infection compared with well-nourished elderly burn patients. Decreased function of the cardiovascular, renal, and pulmonary systems increases the need for close observation of elderly patients with even relatively minor burns during the emergent and acute phases. Acute renal failure is much more common in elderly patients than in those younger than 40 years of age. The margin of difference between hypovolemia and fluid overload is very small. Suppressed immunologic response, a high incidence of malnutrition, and an inability to withstand metabolic stressors (eg, a cold environment) further compromise the elderly person's ability to heal. As a result of these issues in elderly patients who sustain burn injury, close monitoring and prompt treatment of complications are mandatory.

ACUTE/INTERMEDIATE PHASE

The acute/intermediate phase of burn care follows the emergent/resuscitative phase and begins 48 to 72 hours after the burn injury. During this phase, attention is directed toward continued assessment and maintenance of respiratory and circulatory status, fluid and electrolyte balance, and GI function. Infection prevention, burn wound care (ie, wound cleaning, topical antibacterial therapy, wound dressing, dressing changes, wound débridement, and wound grafting), pain management, and nutritional support are priorities at this stage and are discussed in detail in the following sections.

Medical Management

Airway obstruction caused by upper airway edema can take as long as 48 hours to develop. Changes detected by x-ray and arterial blood gas analysis may occur as the effects of resuscitative fluid and the chemical reactions of smoke ingredients with lung tissues become apparent. Pulmonary complications are not unusual in burn injury. Those with ventilator-associated pneumonia (VAP) have a 40% mortality rate, increasing to 60% to 77% for VAP with an inhalation injury. Bronchial washing or bronchioalveolar lavage can assist in the diagnosis and treatment of pneumonia (Wahl, Ahrns, Brandt, et al., 2005). Ideally, the best practice

CHART 57-4 *Ethics and Related Issues*

How Much Is Enough and What Is Comfort Care?

Situation

A 71-year-old woman was flown to the nearest burn center. She lives alone and was cooking on top of a gas stove. She reached over the burner and caught her robe on fire. The flame consumed most of her upper body. She sustained a full-thickness burn to 42% of her body (face, neck, both arms, and chest). In addition, she turned to remove herself from the room quickly, slipped, and fell, fracturing two ribs and spraining her right ankle. Due to the nature of the fire she was enclosed in a burning area so she also sustained an upper airway inhalation injury. She was awake and alert at the scene and indicated a past medical history of diabetes, hypertension, and renal disease. She was in little pain at the time due to the depth of the burn injury; however, she was asking the team questions related to the survivability of her injury, "Am I going to die?"

Upon admission she was intubated to treat her upper airway edema and suspected inhalation injury. Family arrived and the burn surgeon explained the extent of injury. A decision was made to proceed with care and assess her progress postresuscitation. They were prepared for a future decision regarding withdrawal of care if survival becomes futile.

Dilemma

Initial resuscitation has occurred and approximately 4 days postburn the patient begins to show signs of renal failure. She has had one surgical procedure for débridement and grafting to her chest, and although grafts are intact, they do not look healthy. She is showing increased signs of discomfort and pain due to the operative procedure and the addition of another wound (the new donor site). The family decides in a team meeting that they do not want to initiate hemodialysis and therefore place the patient on comfort measures. Approximately 3 days later she remains on comfort care and has increased signs of restlessness and pain. The nurse caring for the patient requests an order from the physician for an increase in pain medication from 5 mg morphine to 10 mg IV. Within 2 hours after administration the patient expired without discomfort. Six months later the facility is contacted by an attorney and informed that the family is taking legal action against the nurse and physician for performing euthanasia on their mother.

Discussion

The burn team is faced with these types of ethical dilemmas on a regular basis. Whenever possible the team should attempt to elicit the patient's wishes as early as possible, including any advanced directives. This should be considered again prior to intubation unless it is an emergency situation. The problem in this case is that due to absence of pain it is often difficult for a patient to understand the severity of his or her burn injury. The patient begins to experience increased pain as care progresses and increased medication is expected. Once the patient is unable to make decisions for herself, family members assume this responsibility. Clear and documented discussions with the family are essential for communication. Decision makers should always make decisions based on what the patient would want them to do, not their individual concerns. They often have difficulty making comfort care decisions; not all family members always agree. If death does not occur rapidly after a decision, they have feelings of remorse and guilt.

Discussion Questions

1. As a member of the team when the patient arrived at your facility, what would you have done differently?
2. Do you believe this was a survivable injury?
3. Given the failing renal status of the patient, do you believe additional medication should have been administered?
4. Do you believe there is reason for the family to seek legal action for their mother's death?

is to remove the endotracheal tube as soon as possible so that a route for pathogens is not accessible to the lungs. The arterial blood gas values and other parameters determine the need for intubation and mechanical ventilation.

As capillaries regain integrity, 48 or more hours after the burn, fluid moves from the interstitial to the intravascular compartment and diuresis begins (Table 57-4). If cardiac or renal function is inadequate, for example in an elderly patient or in a patient with preexisting cardiac disease, fluid overload occurs and symptoms of congestive heart failure may result (see Chapter 30).

Cautious administration of fluids and electrolytes continues during this phase of burn care because of the shifts in fluid from the interstitial to the intravascular compartment, losses of fluid from large burn wounds, and the patient's physiologic responses to the burn injury. Blood components are administered as needed to treat blood loss and anemia.

Fever is common in patients after burn shock resolves. A resetting of the core body temperature in severely burned patients results in a body temperature a few degrees higher than normal for several weeks after the burn. Bacteremia and septicemia also cause fever in many patients. Acetaminophen (Tylenol) and hypothermia blankets and ancillary heating devices may be required to maintain body temperature in a range of 37.2°C to 38.3°C (99°F to 101°F) so as to reduce metabolic stress and tissue oxygen demand.

Table 57-4 FLUID AND ELECTROLYTE CHANGES IN THE ACUTE PHASE

Fluid remobilization phase (state of diuresis)
Interstitial fluid → plasma

Observation	Explanation
Hemodilution (decreased hematocrit)	Blood cell concentration is diluted as fluid enters the intravascular compartment; loss of red blood cells destroyed at burn site.
Increased urinary output	Fluid shift into intravascular compartment increases renal blood flow and causes increased urine formation.
Sodium (Na^+) deficit	With diuresis, sodium is lost with water; existing serum sodium is diluted by water influx.
Potassium (K^+) deficit (occurs occasionally in this phase)	Beginning on the fourth or fifth postburn day, K^+ shifts from extracellular fluid into cells.
Metabolic acidosis	Loss of sodium depletes fixed base; relative carbon dioxide content increases.

CHART 57-5

PLAN OF NURSING CARE
Care of the Patient During the Emergent/Resuscitative Phase of Burn Injury

NURSING DIAGNOSIS: Impaired gas exchange related to carbon monoxide poisoning, smoke inhalation, and upper airway obstruction
GOAL: Maintenance of adequate tissue oxygenation

Nursing Interventions	Rationale	Expected Outcomes
1. Provide humidified oxygen.	1. Humidified oxygen provides moisture to injured tissues; supplemental oxygen increases alveolar oxygenation.	• Absence of dyspnea • Respiratory rate between 12 and 20 breaths/min • Lungs clear on auscultation • Arterial oxygen saturation greater than 96% by pulse oximetry • Arterial blood gas levels within normal limits
2. Assess breath sounds, and respiratory rate, rhythm, depth, and symmetry. Monitor patient for signs of hypoxia.	2. These factors provide baseline data for further assessment and evidence of increasing respiratory compromise.	
3. Observe for the following: a. Erythema or blistering of lips or buccal mucosa b. Singed nostrils c. Burns of face, neck, or chest d. Increasing hoarseness e. Soot in sputum or tracheal tissue in respiratory secretions	3. These signs indicate possible inhalation injury and risk of respiratory dysfunction.	
4. Monitor arterial blood gas values, pulse oximetry readings, and carboxyhemoglobin levels.	4. Increasing $PaCO_2$ and decreasing PaO_2 and O_2 saturation may indicate need for mechanical ventilation.	
5. Report labored respirations, decreased depth of respirations, or signs of hypoxia to physician immediately.	5. Immediate intervention is indicated for respiratory difficulty.	
6. Prepare to assist with intubation and escharotomies.	6. Intubation allows mechanical ventilation. Escharotomy enables chest excursion in circumferential chest burns.	
7. Monitor mechanically ventilated patient closely.	7. Monitoring allows early detection of decreasing respiratory status or complications of mechanical ventilation.	

NURSING DIAGNOSIS: Ineffective airway clearance related to edema and effects of smoke inhalation
GOAL: Maintain patent airway and adequate airway clearance

Nursing Interventions	Rationale	Expected Outcomes
1. Maintain patent airway through proper patient positioning, removal of secretions, and artificial airway if needed.	1. A patent airway is crucial to respiration.	• Patent airway • Respiratory secretions are minimal, colorless, and thin • Respiratory rate, pattern, and breath sounds normal
2. Provide humidified oxygen.	2. Humidity liquefies secretions and facilitates expectoration.	
3. Encourage patient to turn, cough, and deep breathe. Encourage patient to use incentive spirometry. Suction as needed.	3. These activities promote mobilization and removal of secretions.	

NURSING DIAGNOSIS: Fluid volume deficit related to increased capillary permeability and evaporative losses from the burn wound
GOAL: Restoration of optimal fluid and electrolyte balance and perfusion of vital organs

Nursing Interventions	Rationale	Expected Outcomes
1. Observe vital signs (including central venous pressure or pulmonary artery pressure, if indicated) and urine output, and be alert for signs of hypovolemia or fluid overload.	1. Hypovolemia is a major risk immediately after the burn injury. Overresuscitation might cause fluid overload.	• Serum electrolytes within normal limits • Urine output between 0.5 and 1.0 mL/kg/h • Blood pressure higher than 90/60 mm Hg • Heart rate less than 120 beats/min • Exhibits clear sensorium • Voids clear yellow urine with specific gravity within normal limits
2. Monitor urine output at least hourly and weigh patient daily.	2. Output and weight provide information about renal perfusion, adequacy of fluid replacement, and fluid requirement and fluid status.	

Continued on following page

CHART 57-5 PLAN OF NURSING CARE

Care of the Patient During the Emergent/Resuscitative Phase of Burn Injury (Continued)

Nursing Interventions	Rationale	Expected Outcomes
3. Maintain IV lines and regulate fluids at appropriate rates, as prescribed.	3. Adequate fluids are necessary to maintain fluid and electrolyte balance and perfusion of vital organs.	
4. Observe for symptoms of deficiency or excess of serum sodium, potassium, calcium, phosphorus, and bicarbonate.	4. Rapid shifts in fluid and electrolyte status are possible in the postburn period.	
5. Elevate head of patient's bed and elevate burned extremities.	5. Elevation promotes venous return.	
6. Notify physician immediately of decreased urine output, blood pressure, central venous, pulmonary artery, or pulmonary artery wedge pressures, or increased pulse rate.	6. Because of the rapid fluid shifts in burn shock, fluid deficit must be detected early so that distributive shock does not occur.	
NURSING DIAGNOSIS: Hypothermia related to loss of skin microcirculation and open wounds **GOAL:** Maintenance of adequate body temperature		
Nursing Interventions	**Rationale**	**Expected Outcomes**
1. Provide a warm environment through use of heat shield, space blanket, heat lights, or blankets.	1. A stable environment minimizes evaporative heat loss.	• Body temperature remains 36.1°C to 38.3°C (97°F to 101°F) • Absence of chills or shivering
2. Work quickly when wounds must be exposed.	2. Minimal exposure minimizes heat loss from wound.	
3. Assess core body temperature frequently.	3. Frequent temperature assessments help detect developing hypothermia.	
NURSING DIAGNOSIS: Pain related to tissue and nerve injury and emotional impact of injury **GOAL:** Control of pain		
Nursing Interventions	**Rationale**	**Expected Outcomes**
1. Use pain intensity scale to assess pain level (ie, 1 to 10). Differentiate restlessness due to pain from restlessness due to hypoxia.	1. Pain level provides baseline for evaluating effectiveness of pain relief measures. Hypoxia can cause similar signs and must be ruled out before analgesic medication is administered.	• States pain level is decreased • Absence of nonverbal cues of pain
2. Administer intravenous opioid analgesics as prescribed. Observe for respiratory depression in the patient who is not mechanically ventilated. Assess response to analgesic.	2. Intravenous administration is necessary because of altered tissue perfusion from burn injury.	
3. Provide emotional support and reassurance.	3. Emotional support is essential to reduce fear and anxiety resulting from burn injury. Fear and anxiety increase the perception of pain.	
NURSING DIAGNOSIS: Anxiety related to fear and the emotional impact of burn injury **GOAL:** Minimization of patient's and family's anxiety		
Nursing Interventions	**Rationale**	**Expected Outcomes**
1. Assess patient's and family's understanding of burn injury, coping skills, and family dynamics.	1. Previous successful coping strategies can be fostered for use in the present crisis. Assessment allows planning of individualized interventions.	• Patient and family verbalize understanding of emergent burn care • Able to answer simple questions
2. Individualize responses to the patient's and family's coping level.	2. Reactions to burn injury are extremely variable. Interventions must be appropriate to the patient's and family's present level of coping.	

Continued

CHART 57-5 PLAN OF NURSING CARE

Care of the Patient During the Emergent/Resuscitative Phase of Burn Injury (Continued)

Nursing Interventions	Rationale	Expected Outcomes
3. Explain all procedures to the patient and the family in clear, simple terms.	3. Increased understanding alleviates fear of the unknown. High levels of anxiety may interfere with understanding of complex explanations.	
4. Maintain adequate pain relief.	4. Pain increases anxiety.	
5. Consider administering prescribed antianxiety medications if the patient remains extremely anxious despite nonpharmacologic interventions.	5. Anxiety levels during the emergent phase may exceed the patient's coping abilities. Medication decreases physiologic and psychological anxiety responses.	
COLLABORATIVE PROBLEMS: Acute respiratory failure, distributive shock, acute renal failure, compartment syndrome, paralytic ileus, Curling's ulcer **GOAL:** Absence of complications		
Nursing Interventions	**Rationale**	**Expected Outcomes**
Acute Respiratory Failure		
1. Assess for increasing dyspnea, stridor, changes in respiratory patterns.	1. Such signs reflect deteriorating respiratory status.	• Arterial blood gas values within acceptable limits: PaO_2 greater than 80 mm Hg, $PaCO_2$ less than 50 mm Hg • Breathes spontaneously with adequate tidal volume • Chest x-ray findings normal • Absence of cerebral signs of hypoxia
2. Monitor pulse oximetry, arterial blood gas values for decreasing PaO_2 and oxygen saturation, and increasing $PaCO_2$.	2. Such signs reflect decreased oxygenation status.	
3. Monitor chest x-ray results.	3. X-ray may disclose pulmonary injury.	
4. Assess for restlessness, confusion, difficulty attending to questions, or decreasing level of consciousness.	4. Such manifestations may indicate cerebral hypoxia.	
5. Report deteriorating respiratory status immediately to physician.	5. Acute respiratory failure is life-threatening, and immediate intervention is required.	
6. Prepare to assist with intubation or escharotomies as indicated.	6. Intubation allows mechanical ventilation. Escharotomies allow improved chest excursion with respirations.	
Distributive Shock		
1. Assess for decreasing urine output and blood pressure as well as increasing pulse rate. (If hemodynamic monitoring is used, assess for decreasing pulmonary artery and pulmonary artery wedge pressures and cardiac output.)	1. Such signs and symptoms may indicate distributive shock and inadequate intravascular volume.	• Urine output between 0.5 and 1.0 mL/kg/h • Blood pressure within patient's normal range (usually greater than 90/60 mm Hg) • Heart rate within patient's normal range (usually less than110/min) • Pressures and cardiac output remain within normal limits
2. Assess for progressive edema as fluid shifts occur.	2. As fluid shifts into the interstitial spaces in burn shock, edema occurs and may compromise tissue perfusion.	
3. Adjust fluid resuscitation in collaboration with the physician in response to physiologic findings.	3. Optimal fluid resuscitation prevents distributive shock and improves patient outcomes.	
Acute Renal Failure		
1. Monitor urine output and blood urea nitrogen (BUN) and serum creatinine levels.	1. These values reflect renal function.	• Adequate urine output • BUN and serum creatinine values remain normal
2. Report decreased urine output or increased BUN and creatinine values to physician.	2. These laboratory values indicate possible renal failure.	
3. Assess urine for hemoglobin or myoglobin.	3. Hemoglobin or myoglobin in the urine points to an increased risk of renal failure.	

Continued on following page

CHART 57-5 PLAN OF NURSING CARE

Care of the Patient During the Emergent/Resuscitative Phase of Burn Injury (Continued)

Nursing Interventions	Rationale	Expected Outcomes
4. Administer increased fluids as prescribed.	4. Fluids help to flush hemoglobin and myoglobin from renal tubules, decreasing the potential for renal failure.	
Compartment Syndrome		
1. Assess peripheral pulses hourly with Doppler ultrasound device.	1. Assessment with Doppler device substitutes for auscultation and indicates characteristics of arterial blood flow.	• Absence of paresthesias or symptoms of ischemia of nerves and muscles • Peripheral pulses detectable by Doppler
2. Assess warmth, capillary refill, sensation, and movement of extremity hourly. Compare affected with unaffected extremity.	2. These assessments indicate characteristics of peripheral perfusion.	
3. Remove blood pressure cuff after each reading.	3. Cuff may act as a tourniquet as extremities swell.	
4. Elevate burned extremities.	4. Elevation reduces edema formation.	
5. Report loss of pulse or sensation or presence of pain to physician immediately.	5. These signs and symptoms may indicate inadequate tissue perfusion.	
6. Prepare to assist with escharotomies.	6. Escharotomies relieve the constriction caused by swelling under circumferential burns and improve tissue perfusion.	
Paralytic Ileus		
1. Maintain nasogastric tube on low intermittent suction until bowel sounds resume.	1. This measure relieves gastric and abdominal distention, also prevents vomiting.	• Absence of abdominal distention • Normal bowel sounds within 48 hours
2. Auscultate for bowel sounds, abdominal distention.	2. As bowel sounds resume, feeding may be slowly initiated. Abdominal distention reflects inadequate decompression.	
Curling's Ulcer		
1. Assess gastric aspirate for pH and blood.	1. Acidic pH indicates need for antacids or histamine blockers. Blood indicates possible gastric bleeding.	• Absence of abdominal distention • Normal bowel sounds within 48 hours • Gastric aspirate and stools do not contain blood
2. Assess stools for occult blood.	2. Blood in stools may indicate gastric or duodenal ulcer.	
3. Administer histamine blockers and antacids as prescribed.	3. Such medications reduce gastric acidity and risk of ulceration.	

Central venous, peripheral arterial, or pulmonary artery thermodilution catheters may be required for monitoring venous and arterial pressures, pulmonary artery pressures, pulmonary capillary wedge pressures, or cardiac output. It is not uncommon for patients with major burns to have multiple invasive line sites due to the amount and frequency of fluid and medication that need to be administered. Whenever possible, burned areas of the body are avoided as sites for insertion of invasive lines.

Infection Prevention

Infection progressing to sepsis is the major cause of death in patients who have survived the first few days after a major burn. Burn patients are at risk for infection for a few reasons. The loss of skin removes their ability to protect themselves from the environment. The longer length of stay in the hospital predisposes them to hospital-associated infections. The number and frequency of invasive procedures, both in the patient room and in the operating room, increase the risk of infection. Lastly, immunosuppression that accompanies extensive burn injury places patients at high risk. The nursing goal is to provide protection and safety in the patients' environment to ultimately prevent or control infection in the burn population (Hodle, Richter & Thompson, 2006).

The burn wound is an excellent medium for bacterial growth and proliferation. The burn eschar is nonviable tissue and has no blood supply; therefore, neither leukocytes or antibodies nor systemic antibiotics can reach the area. More than 1 billion bacteria per gram of tissue may

be present and subsequently spread to the bloodstream or release their toxins, which reach distant sites. *Pseudomonas* is the major challenge in 44% of burn centers. Other common organisms are methicillin-resistant *Staphylococcus aureus* (MRSA) and *Acinetobacter*. Important but somewhat less common are *Staphylococcus* and vancomycin-resistant enterococci (VRE) (Hodle, et al., 2006). *Staphylococcus* and *Enterococci* are responsible for more than 50% of nosocomial bloodstream infections in patients with burn injuries. Other bacteria that are important in burn care include *Proteus*, *Escherichia coli*, and *Klebsiella*. Bloodstream infections are confirmed if two positive blood cultures are obtained or if one positive culture is obtained in the presence of clinical signs of sepsis (Greenhalgh, 2007). Fungi such as *Candida albicans* also grow easily in burn wounds.

Infection impedes burn wound healing by promoting excessive inflammation and damaging tissue. When the burn wound is healing through spontaneous reepithelialization or is being prepared for skin grafting, it must be protected from sepsis. Characteristics of burn wound sepsis are 10^5 bacteria per gram of tissue, inflammation or destruction of unburned skin, and invasive infection with or without signs of sepsis (Greenhalgh, 2007).

A primary source of bacterial infection is the patient's intestinal tract, the source of most microbes. The intestinal mucosa normally serves as a barrier to keep the internal environment free from a variety of pathogens. After a severe burn injury, the intestinal mucosa becomes markedly permeable (Gosain & Gamelli, 2005b), allowing microbial flora and endotoxins to pass freely into the systemic circulation and causing infection. Early enteral feeding is one strategy to help avoid increased intestinal permeability and prevent early endotoxin translocation (De-Souza & Greene, 2005).

A major secondary source of pathogenic microbes is the environment. Compliance with infection-control policies has been identified as the single greatest challenge along with the abundance of resistant organisms (Hodle, et al., 2006). Burn centers are designed with specific measures to reduce the risk of infection: private rooms and bathrooms; increased airflow within patient rooms to create a more positive airflow; low humidification to prevent bacterial growth; limited use of cloth (eg, patient privacy curtains, window treatments); accessibility of proper protective equipment such as caps, masks, gowns and gloves; convenient and available hand washing/hand hygiene areas; and room design with antidust and dirt collection areas.

Use of cap, gown, mask, and gloves is essential while caring for the patient with open burn wounds. Aseptic technique is used when caring directly for burn wounds. Gowns and gloves are worn by all caregivers and visitors; hand hygiene is used before and after leaving the patient room. Special instruction is given to all visitors with the goal of preventing the spread of infection because of the immunosuppression experienced by patients with burns.

Bacteria are found on all skin surfaces; by itself, their presence does not determine burn infection. Constant monitoring and observation of the wound (eg, changes in the wound, presence of purulent drainage, pain, and increasing depth of burn wound) are needed to detect wound infection. Tissue specimens may be obtained for culture to monitor colonization (Greenhalgh, 2007). Antibiotics are seldom prescribed prophylactically because of the risk of promoting resistant strains of bacteria. Systemic antibiotics are administered when there is documented burn wound sepsis or other positive cultures such as urine, sputum, or blood. Sensitivity of the organisms to the prescribed antibiotics should be determined before administration. Careful attention is paid to antibiotic use in the burn unit because inappropriate use of antibiotics significantly affects the microbial flora present in the burn unit and increases the risk of drug resistance.

Wound Cleaning

Various measures are used to clean the burn wound, such as **hydrotherapy.** If the patient is ambulatory, the wounds can be cleansed in a shower. The wounds of nonambulatory patients can be cleansed using shower carts—mobile stretchers made with removable sides, drainage holes, and positioning capabilities. Retractable shower hoses suspended from walls and ceilings provide the nurse with easy access to a water source for washing the wounds. Unstable patients may have their wounds washed at the bedside. Total immersion hydrotherapy is rarely performed. Because of the high risk for infection and sepsis, the use of plastic liners, water filters, and thorough decontamination of hydrotherapy equipment and wound care areas is required to prevent cross-contamination. The temperature of the water is maintained at 37.8°C (100°F), and the temperature of the room should be maintained between 26.6°C and 29.4°C (80°F to 85°F). The duration of wound cleansing and dressing change is determined by the patient's ability to tolerate the treatment and to maintain a satisfactory body temperature.

During the bath, the patient is encouraged to be as active as possible. Hydrotherapy provides an excellent opportunity for exercising the extremities and cleaning the entire body. When the patient is removed, any residue adhering to the body is washed away with a clear water spray or shower. Unburned areas, including the hair, must be washed regularly as well. At the time of wound cleaning, all skin is inspected for any hints of redness, breakdown, or local infection. Hair in and around the burn area, except the eyebrows, should be clipped short or shaved. Intact blisters should be left alone and débrided only if they rupture or break.

Conscientious management of the burn wound is essential. When nonviable loose skin is removed, aseptic conditions must be established. Wound cleansing is usually performed daily in wound areas that are not undergoing surgical intervention. Mechanical débridement can be performed to remove loose nonviable tissue. However, surgical removal as soon as possible is preferred.

After the burn wounds are cleaned, they are gently patted dry, and the prescribed method of wound care is performed. Whatever the method is used, the goal is to protect the wound from overwhelming proliferation of pathogenic organisms and invasion of deeper tissues until either spontaneous healing or skin grafting can be achieved.

Patient comfort and ability to participate in the prescribed treatment are also important considerations. During the treatment, the patient is assessed for signs of chilling, fatigue, changes in hemodynamic status, and pain unrelieved by analgesic medications or relaxation techniques.

Topical Antibacterial Therapy

Variations in topical wound care for nonsurgical burn wounds exist among burn centers across the country and choices are made based on the individualized needs of each patient. There is general agreement that some form of antimicrobial therapy applied to the burn wound is an acceptable method of local care in extensive burn injury. Silver sulfadiazine is considered the gold standard for protecting wounds from infection (Caruso, Foster, Blome-Eberwein, et al., 2006). Topical antibacterial therapy becomes more important in the deep dermal and full-thickness injury because they are more prone to infection. Silver has been introduced into a variety of topical treatments because of its broad spectrum effectiveness against *Staphylococcus aureus* and *Pseudomonas aeruginosa* (Pham & Gibran, 2007). The goal of topical therapy is to provide a dressing that

- Is effective against gram-positive and gram-negative organisms and fungi,
- Penetrates the eschar but is not systemically toxic,
- Does not lose effectiveness or allow another infection to develop,
- Is cost-effective, available, and acceptable to the patient,
- Is easy to apply and remove, and decreases the frequency of dressing changes, decreases pain, and minimizes nursing time.

Table 57-5 describes three commonly used topical agents, silver sulfadiazine (Silvadene), silver nitrate, and mafenide acetate (Sulfamylon), two of which contain silver. Many other topical agents are available, including povidone–iodine ointment 10% (Betadine), gentamicin sulfate, nitrofurazone (Furacin), Dakin's solution, acetic acid, and antifungal agents (miconazole, clotrimazole, and mupirocin [Bactroban]). Bacitracin or a triple antibiotic agent may be used for facial burns or on skin grafts initially.

No single topical medication is universally effective, and use of different agents at different times in the postburn period may be necessary. Prudent use and alternation of antimicrobial agents result in less-resistant strains of bacteria, greater effectiveness of the agents, and a decreased risk of sepsis.

Table 57-5 OVERVIEW OF SELECTED TOPICAL ANTIBACTERIAL AGENTS USED FOR BURN WOUNDS

Agent	Indication/Comment	Application	Nursing Implications
Silver sulfadiazine 1% (Silvadene) water-soluble cream	• Most bactericidal agent • Minimal penetration of eschar	Apply 1/16-inch layer of cream with a sterile glove 1–3 times daily.	• Watch for leukopenia 2–3 days after initiation of therapy. (Leukopenia usually resolves within 2–3 days.) • Anticipate formation of pseudo-eschar (proteinaceous gel), which is removed easily after 72 hours.
Mafenide acetate 5% to 10% (Sulfamylon) hydrophilic-based cream	• Effective against gram-negative and gram-positive organisms • Diffuses rapidly through eschar • In 10% strength, it is the agent of choice for electrical burns because of its ability to penetrate thick eschar	Apply thin layer with sterile glove twice a day and leave open as prescribed; if the wound is dressed, change the dressing every 6 hours as prescribed.	• Monitor arterial blood gas levels and discontinue as prescribed, if acidosis occurs. Mafenide acetate is a strong carbonic anhydrase inhibitor that may reduce renal buffering and cause metabolic acidosis. • Premedicate the patient with an analgesic before applying mafenide acetate because this agent causes severe burning pain for up to 20 minutes after application.
Silver nitrate 0.5% aqueous solution	• Bacteriostatic and fungicidal • Does not penetrate eschar	Apply solution to gauze dressing and place over wound. Keep the dressing wet but covered with dry gauze and dry blankets to decrease vaporization. Remoisten every 2 hours, and redress wound twice a day.	• Monitor serum sodium (Na^+) and potassium (K^+) levels and replace as prescribed. Silver nitrate solution is hypotonic and acts as wick for sodium and potassium. • Protect bed linen and clothing from contact with silver nitrate, which stains everything it touches black.
Acticoat	• Effective against gram-negative and gram-positive organisms and some yeasts and molds • Delivers a uniform, antimicrobial concentration of silver to the burn wound	Moisten with sterile water only (never use normal saline). Apply directly to wound. Cover with absorbent secondary dressing. Remoisten every 3–4 hours with sterile water.	• Do not use oil-based products or topical antimicrobials with Acticoat burn dressing. Keep Acticoat moist, not saturated. May produce a "pseudo-eschar" from silver after application. • Can be left in place for 3–5 days. Also available in Acticoat 7, which can be left in place for up to 7 days without the need to change the dressing.

Wound Dressing

After wound cleaning, the burned areas are patted dry and the prescribed topical agent is applied; the wound is then covered with several layers of dressings. A light dressing is used over joint areas to allow for motion (unless the particular area has a graft and motion is contraindicated). A light dressing is also applied over areas for which a splint has been designed to conform to the body contour for proper positioning. Circumferential dressings should be applied distally to proximally. If the hand or foot is burned, the fingers and toes should be wrapped individually to promote adequate healing.

Burns to the face may be left open to air once they have been cleaned and the topical agent has been applied. Careful attention must be given to ensure that the topical agent does not interfere with the eyes or mouth. A light dressing can be applied to the face to absorb excess exudates that might run into the eyes, causing irritation.

Occlusive dressings may be used over areas with new skin grafts to protect the graft and promote an optimal condition for its adherence to the recipient site. An occlusive dressing is a thin gauze that is impregnated with a topical antimicrobial agent or is applied after application of a topical antimicrobial agent. Ideally, these dressings remain in place for 3 to 5 days, at which time they are removed for examination of the graft. When occlusive dressings are applied, precautions are taken to prevent two body surfaces from touching, such as fingers or toes, ear and scalp, the areas under the breasts, any point of flexion, or between the genital folds. Functional body alignment positions are maintained by using splints or by regular repositioning of the patient.

NURSING ALERT

Dressings impede circulation if they are too tightly wrapped. The peripheral pulses must be checked frequently and burned extremities elevated on two pillows. Extremities are always wrapped from distal to proximal to the heart. If the patient's pulse is diminished, this is a critical situation and must be addressed immediately.

Dressings that adhere to the wound can be removed more comfortably and without damaging healing tissue by moistening the wound with tap water. The remaining dressings are carefully and gently removed. The patient may participate in removing the dressings, providing some degree of control over this painful procedure. The wounds are then cleaned and débrided to remove any remaining topical agent, exudate, and dead skin. Sterile scissors and forceps may be used to trim loose eschar and encourage separation of devitalized skin. During this procedure, the wound and surrounding skin are carefully inspected. The color, odor, size, exudate, signs of reepithelialization, and other characteristics of the wound and the eschar and any changes from the previous dressing change are noted.

Wound Débridement

The goals of, **débridement,** the removal of devitalized tissue, are:

- Removal of tissue contaminated by bacteria and foreign bodies, thereby protecting the patient from invasion of bacteria
- Removal of devitalized tissue or burn eschar in preparation for grafting and wound healing

There are three types of débridement—natural, mechanical, and surgical.

Natural Débridement

With natural débridement, the dead tissue separates from the underlying viable tissue spontaneously. Bacteria that are present at the interface of the burned tissue and the viable tissue underneath gradually liquefy the fibrils of **collagen** that hold the eschar in place for the first or second postburn weeks. Proteolytic and other natural enzymes cause this phenomenon. However, use of antibacterial topical agents tends to slow this natural process of eschar separation and slows the healing process.

Mechanical Débridement

Mechanical débridement involves the use of surgical scissors, scalpels, and forceps to separate and remove the eschar. This technique can be performed by skilled physicians, nurses, or physical therapists and is usually done with daily dressing changes. If bleeding occurs, hemostatic agents or pressure can be used to stop the bleeding from small vessels. Wet-to-dry dressings are not advocated in burn care because of the chance of removing viable cells along with necrotic tissue. Dressing changes alone aid the removal of wound debris.

Chemical Débridement

Topical enzymatic débridement agents are available to promote débridement of the burn wounds. Because such agents usually do not have antimicrobial properties, they should be used together with topical antibacterial therapy to protect the patient from bacterial invasion. Heavy metals such as silver deactivate the débriding agent; therefore, caution is necessary to ensure that the débriding agent does not interfere with the topical antimicrobial agent. Separate dressings are used to prevent this from occurring.

Surgical Débridement

Early surgical excision to remove devitalized tissue along with early burn wound closure is now recognized as one of the most important factors contributing to survival in a patient with a major burn injury. Aggressive surgical wound closure has reduced the incidence of burn wound sepsis, thus improving survival rates (Burke, 2005). Early excision is carried out before the natural separation of eschar is allowed to occur.

Surgical débridement is an operative procedure involving either primary **excision** (surgical removal of tissue) of the full thickness of the skin down to the fascia (tangential excision) or shaving of the burned skin layers gradually down to freely bleeding, viable tissue. Surgical excision is initiated early in burn wound management. This may be performed within the first few days after the burn or as soon as the patient is hemodynamically stable and edema has decreased. Ideally, the wound is then covered immediately with a skin graft, if needed, and an occlusive dressing. If the wound bed is not ready for a skin graft at the time of excision, a temporary biologic dressing may be used until a skin graft can be applied during subsequent surgery.

The use of surgical excision carries with it risks and complications, especially with large burns. The procedure creates a high risk of extensive blood loss (as much as 100 to 125 mL of blood per percentage of body surface excised) and lengthy operating and anesthesia times. However, when conducted in a timely and efficient manner, surgical excision results in shorter hospital stays and possibly a decreased risk of complications from invasive burn wound sepsis.

Gerontologic Considerations

Eschar separation in full-thickness burns is typically delayed in elderly patients, and older patients are frequently poor risks for surgical excision. For these reasons, prolonged hospitalization, immobilization, and associated problems are common. If the elderly patient can tolerate surgery, early excision with skin grafting is the treatment of choice because it decreases the mortality rate in this population. If the patient is not a surgical candidate, chemical débridement is often chosen to enhance the removal of eschar over time. Prevention of complications of prolonged hospitalization, immobility, and surgery is essential in the care of the elderly burn patient.

Wound Grafting

The patient with deep partial-thickness or full-thickness burns may be a candidate for skin grafting. If so, temporary coverage of the burn wound is necessary until coverage with a graft of the patient's own skin (**autograft**) is possible. The purposes of wound coverage are to decrease the risk of infection; prevent further loss of protein, fluid, and electrolytes through the wound; and minimize heat loss through evaporation. Several methods of wound coverage are available; some are temporary until grafting with permanent coverage is possible. Wound coverage may consist of biologic, biosynthetic, synthetic, and autologous methods or a combination of these approaches.

The main areas for skin grafting include the face (for cosmetic and psychological reasons); functional areas, such as the hands and feet; and areas that involve joints. Grafting permits earlier functional ability and reduces wound **contractures.** When burns are very extensive, the order in which areas are grafted is chosen based on the ability to achieve wound closure as soon as possible, and, therefore, the chest and abdomen or back may be grafted first to reduce the burn surface.

Granulation tissue fills the space created by the wound, creates a barrier to bacteria, and serves as a bed for epithelial cell growth. Richly vascular granulation tissue is pink, firm, shiny, and free of exudate and debris. It should have a bacterial count of less than 100,000/g of tissue to optimize graft success. If the wound is not ready for skin grafting, the burn wound is excised and allowed to granulate. Once the wound is excised, a wound covering is applied to keep the wound bed moist and promote the granulation process.

Biologic Dressings (Homografts and Heterografts)

Biologic dressings have several uses. In extensive burns, they provide temporary wound coverage and protect the granulation tissue until autografting is possible. Biologic dressings are commonly used in patients with large areas of burn and little remaining normal skin for donor sites. They can be used as a test graft in preparation for the patient's own skin graft to determine if the bed will accept the graft. Once the biologic dressing appears to be "taking," or adhering to the granulating surface with minimal underlying exudation, the patient is ready for an autologous skin graft.

Biologic dressings also provide temporary immediate coverage for clean, superficial burns and decrease the wound's evaporative water and protein loss. They decrease pain by protecting nerve endings and are an effective barrier against water loss and entry of bacteria. When applied to superficial partial-thickness wounds, they seem to speed healing. Biologic materials can be left open or covered. They stay in place for varying lengths of time but are removed in instances of infection or rejection. Another advantage for the patient is that these dressings often require fewer dressing changes, therefore, decreasing pain. They can also be used in the outpatient environment.

Biologic dressings consist of **homografts** (or allografts) and **heterografts** (or xenografts). Homografts are skin obtained from living or recently deceased humans. Heterografts consist of skin taken from animals (usually pigs). Most biologic dressings are used as temporary coverings of burn wounds and are eventually rejected because of the body's immune reaction to them as foreign.

Homografts tend to be the most expensive biologic dressings. They are available from skin banks in fresh and cryopreserved (frozen) forms. Homografts are thought to provide the best infection control of all the biologic or biosynthetic dressings available. Revascularization occurs within 48 hours, and the graft may be left in place for several weeks.

Pigskin is available from commercial suppliers. It is available fresh, frozen, or lyophilized (freeze dried) for longer shelf life. Pigskin is used for temporary covering of clean wounds such as superficial partial-thickness wounds and donor sites. Although pigskin does not vascularize, it does adhere to clean superficial wounds and provides excellent pain control while the underlying wound epithelializes (Atiyeh, et al., 2005).

Biosynthetic and Synthetic Dressings

Problems with availability, sterility, and cost have prompted the search for biosynthetic and synthetic skin substitutes, which may eventually replace biologic dressings as temporary wound coverings. A widely used synthetic dressing is **Biobrane,** which is composed of a nylon, silastic membrane combined with a collagen derivative. The material is semitransparent and sterile. It has an indefinite shelf life and is less costly than homograft or pigskin. Like biologic dressings, Biobrane protects the wound from fluid loss and bacterial invasion (Fig. 57-4).

Biobrane adheres to the wound fibrin, which binds to the nylon–collagen material. Within 5 days, cells migrate into the nylon mesh. In general, adherence to the wound surface correlates directly with low bacterial counts. When the Biobrane dressing adheres to the wound, the wound remains stable. Biobrane can remain in place until spontaneous epithelialization and wound healing occur. It can be laid on top of a wide-meshed autograft to protect the wound until the autograft epithelium grows out to close the interstices. As the Biobrane gradually separates, it is trimmed, leaving a healed wound.

Another temporary wound covering is BCG Matrix. This dressing combines beta-glucan, a complex carbohydrate, with collagen in a meshed reinforced wound dressing. Beta-glucan is known to stimulate macrophages, which are vital in the inflammatory process of healing. BCG Matrix is

Figure 57-4 Biobrane dressing for partial-thickness burn wound. Biobrane dressing applied to a clean wound bed on the hand. Used with permission. Lehigh Valley Health Network, Allentown, PA.

a temporary wound covering intended for use with partial-thickness burns and donor sites. It is applied immediately after cleaning and débridement. If the burn wound surface remains free of infection, BCG Matrix can be left in place until healing is complete (Atiyeh, et al., 2005).

Several other synthetic dressings are available for burn wound care. Op-Site, a thin, transparent, polyurethane elastic film, can be used to cover clean partial-thickness wounds and donor sites. This dressing is occlusive and waterproof but permeable to water vapor and air; this permeability not only provides protection from microbial contamination but also allows for the exchange of gases, which occurs much more quickly in a moist environment. Other synthetic dressings used for burn wounds include Tegaderm, N-Terface, and DuoDerm.

Skin Substitutes

In an attempt to develop the ideal burn wound covering product, skin substitutes have been created that surgically replace the epidermis and the dermis. It is believed that skin substitutes enhance the healing process of an open wound when autologous skin is unavailable or limited for use. These products are often the choice when donor sites are inadequate or unavailable.

A **cultured epithelial autograft (CEA)** provides permanent coverage of large wounds when harvesting of skin for autografting is not an option. This involves a biopsy of the patient's skin in an unburned area. Keratinocytes are isolated, and epithelial cells are cultured in a laboratory. The original epithelial cell reproduces multiple plated sheets of CEA to cover an already surgically excised wound. These cells are then attached to the burn wound surface, and extreme care is taken until they have adhered to the wound surface. Varying degrees of success have been reported and results are encouraging. However, the disadvantages of the CEA are that the grafts are thin and fragile and can shear easily. Patients have longer hospital stays and higher hospital costs and require more surgical procedures than those treated by traditional methods. In addition, patients require more reconstructive procedures in the first 1 to 2 years after injury. Therefore, CEA use is very limited and is reserved for burn patients whose donor sites are limited (Pham & Gibran, 2007).

Two dermal substitutes are **Integra** Artificial Skin and **AlloDerm**. Artificial skin (Integra) is the newest type of dermal substitute (Fig. 57-5). A dermal analogue, Integra is

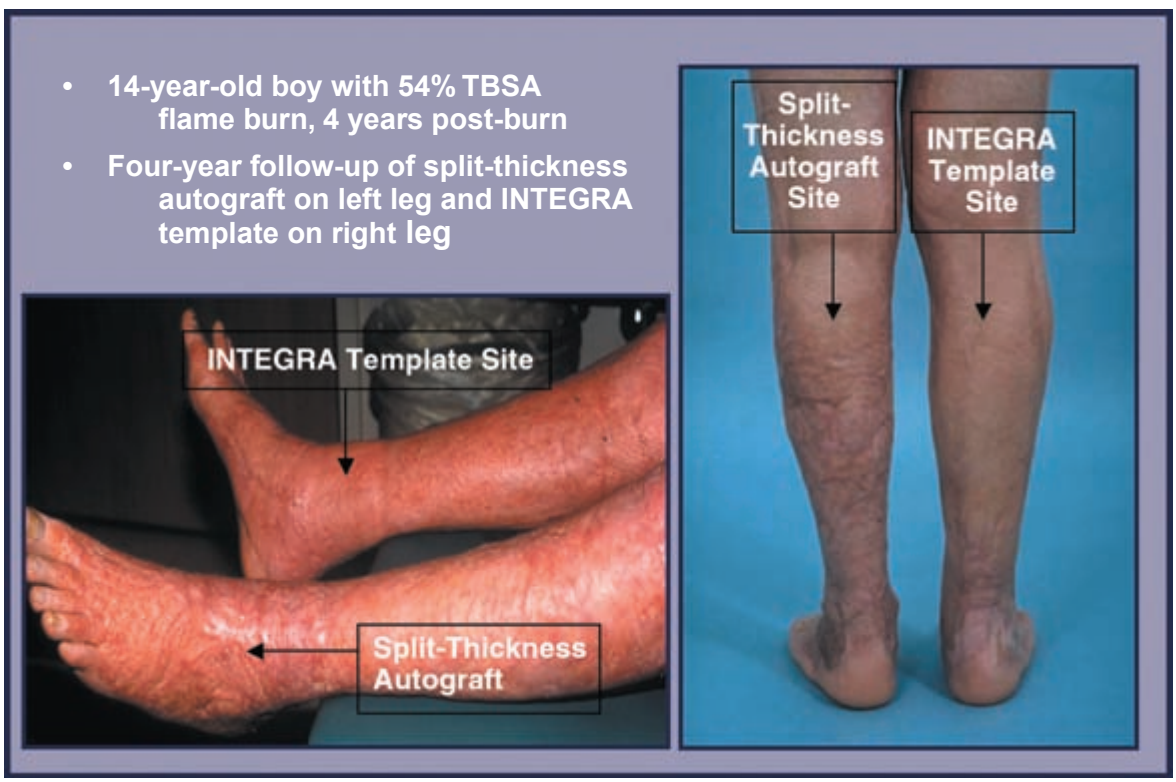

Figure 57-5 Comparison of Integra template site (*right leg*) to split-thickness autograft site (*left leg*). Used with permission from Glenn Warden, MD.

composed of two main layers. The epidermal layer, consisting of silicone, acts as a bacterial barrier and prevents water loss from the dermis. The dermal layer is composed of animal collagen. It interfaces with the open wound surface and allows migration of fibroblasts and capillaries into the material. This "neodermis" becomes a permanent structure. The artificial dermis is biodegraded and reabsorbed. The outer silicone membrane is removed 2 weeks after application and is replaced with the patient's own skin in the form of a thin epidermal skin graft. When a thinner autologous donor graft is used, donor site healing is quicker. Long-term effects of Integra include minimal contracture formation. The graft site is very pliable, almost eliminating the need for repeated cosmetic surgery. Most important, Integra has resulted in less hypertrophic scarring, thus reducing the need for compression devices once the burn wound has healed. Because Integra allows for earlier excision and coverage of the burn wound, metabolic demands of the patient are reduced. Integra allows for the increased survivability of patients with large burn injuries and improves the functional and cosmetic qualities of the healed burns. The combination of Integra with cultured skin substitutes has demonstrated promise in burn management (Pham & Gibran, 2007).

Another promising dermal substitute is AlloDerm. It is processed dermis from human cadaver skin, which can be used as the dermal layer for skin grafts. When a **donor site** (the area from which skin is taken to provide a skin graft for another part of the body) is harvested for an autologous skin graft, both the epidermal and the dermal layers of skin are removed from the donor site. AlloDerm provides a permanent dermal layer replacement. Its use allows the burn surgeon to harvest a thinner skin graft, consisting of the epidermal layer only. The patient's epidermal layer is placed directly over the dermal base (AlloDerm). The new graft is then treated according to the burn unit's protocol. Use of AlloDerm has also resulted in less scarring and contractures with healed grafts; donor sites heal more quickly than conventional donor sites because only the epidermal layer has been harvested. This is important when donor sites are limited because of extensive burns (Boyce, Greenhalgh, Palmieri, et al., 2006; Pham & Gibran, 2007).

Autografts

Autografts remain the preferred material for definitive burn wound closure after excision. Autografts are the ideal means of covering burn wounds because the grafts are the patient's own skin and therefore are not rejected by the patient's immune system. They can be split-thickness (Fig. 57-6), full-thickness, pedicle flaps, or epithelial grafts. Full-thickness autografts and pedicle flaps are commonly used for reconstructive surgery, which may take place months or years after the initial injury.

Split-thickness autografts can be applied in sheets or they can be expanded by meshing so that they cover 1.5 to 9 times more than a given donor site area. Skin meshers enable the surgeon to cut tiny slits into a sheet of donor skin, making it possible to cover large areas with smaller amounts of donor skin. These expanded grafts adhere to the recipient site more easily than sheet grafts and prevent the accumulation of blood, serum, air, or purulent material under the graft. However, any kind of graft other than a sheet graft contributes to scar formation as it heals. Use of expanded grafts may be necessary in large wounds but should be viewed as a compromise in terms of cosmesis.

Figure 57-6 Healed split-thickness skin graft to the chest and upper extremity. Used with permission. Lehigh Valley Health Network, Allentown, PA.

If blood, serum, air, fat, or necrotic tissue lies between the recipient site and the graft, there may be partial or total loss of the graft. Infection or mishandling of the graft and trauma during dressing changes account for most other instances of graft loss. Use of split-thickness grafts allows the remaining donor site to retain sweat glands and hair follicles and minimizes donor site healing time.

Care of the Graft Site. Protection is the key goal of caring for skin grafts postoperatively. Occlusive dressings are commonly used initially after grafting to immobilize the graft. Occupational therapists may be helpful in constructing splints to immobilize newly grafted areas to prevent dislodging of the graft. Homografts, heterografts, or synthetic dressings may also be used to protect grafts.

The first dressing change is usually performed 2 to 5 days after surgery, or earlier in the case of clinical signs of infection, purulent drainage, or a foul odor. Infection, bleeding beneath the graft, and shearing force are the most common reasons for graft loss in the early postoperative period.

The patient is positioned and turned carefully to avoid disturbing the graft or putting pressure on the graft site. If an extremity has been grafted, it is elevated to minimize edema. The patient begins exercising the grafted area 5 to 7 days after grafting.

Care of the Donor Site. Donor sites are clean new wounds that are usually very painful. Caregivers need to recognize this additional source of pain and possible site of infection. Since the donor site is a clean wound created in a surgical environment, it should heal easily unless other complications exist. A moist gauze dressing is applied at the time of surgery to maintain pressure and to stop any oozing. After the donor skin is excised, a thrombostatic agent such as thrombin or epinephrine may be applied directly to the site. The donor site may be covered in several ways, from single-

layer gauze impregnated with petrolatum, scarlet red, or bismuth to new biosynthetic dressings such as Biobrane or BCG Matrix. Acticoat can also be used as a dressing on donor sites. With all types of covering, donor sites must remain clean, dry, and free from pressure. Because a donor site is a partial-thickness wound, it is very painful and will heal spontaneously within 7 to 14 days with proper care.

Pain Management

The ability to quantify pain may be difficult in any patient; however, the patient who has experienced a burn has many additional challenges. A burn injury is considered one of the most painful types of trauma that a patient can endure. The nature of the injury requires multiple procedures, débridement, surgery and treatments. All of these experiences vary in length and intensity, therefore creating variations in sensation. Additional pain occurs with each skin graft because a new painful donor site is created. In addition, moving, changing position, and receiving occupational and physical therapy cause addition discomfort. This is a constantly changing source of pain throughout the entire healing process, and to the patient it appears to be never ending. Therefore, the pain management plan for any patient needs to be flexible, evaluated regularly using standardized scales, and individualized to meet the patient's needs (Faucher & Furukawa, 2006, Connor-Ballard, 2009a, 2009b).

The American Burn Association's guidelines for pain management are: there must be an organized approach to pain management that addresses background, procedural, and breakthrough pain; the goal should be for patients to be comfortable and alert; and pain needs to be differentiated from anxiety (Faucher & Furukawa, 2006).

Background pain is a continuous level of discomfort even when the patient is inactive or not undergoing any procedures. The goal of treatment is to provide a long-acting analgesic that will provide even coverage for this long-term discomfort. It is helpful to use escalating doses when initiating the medication to reach the level of pain control that is acceptable to the patient. The use of patient-controlled analgesia (PCA) gives control to the patient and achieves this goal. Breakthrough pain is described as acute, intense, and episodic pain. It is generally related to an activity or movement of the affected area. Short-acting agents are used to achieve pain control in addition to the baseline treatment the patient receives for background pain. Procedural pain is discomfort that occurs with procedures such as daily wound treatments, invasive line insertions, physical and occupational therapy. The goal is to plan proper sedation that will place the patient in a state of comfort throughout the procedure. Depending on the agent, an anesthesia provider can be helpful in achievement of pain relief (Faucher & Furukawa, 2006).

Most severe burns are a combination of partial-thickness and full-thickness burns and the depth influences the amount of pain the patient experiences. Superficial and deep partial-thickness burns are very painful because the nerve endings are exposed, resulting in excruciating pain with exposure to temperature, pressure, and movement. In a full-thickness burn the nerve endings are destroyed, and upon admission there is numbness and decreased sensation to the area. Thus, severe injuries are often underestimated by the patient because the pain at that time is minimal. Educating patients and their families about burn pain and its relationship to the depth of injury as well as the pain management plan is an important priority for the nurse.

The pharmacologic treatment for the management of burn pain includes the use of opioids, nonsteroidal anti-inflammatory drugs (NASIDs), anxiolytics, and anesthetic agents. These and other pain management strategies are discussed in Chapter 13. Treatment of anxiety with benzodiazepines is used along with opioids to achieve both a pain-free and anxiety-free experience. The use of anesthetics in a nonoperative setting (ie, moderate sedation) requires administration by qualified personnel. Recent advances include the use of agents with rapid onset and short duration, which have been very effective in pain control during a planned procedure (Faucher & Furukawa, 2006).

Nonpharmacologic pain control can be achieved by using relaxation techniques, distraction, guided imagery, hypnosis, therapeutic touch, humor, music therapy, and more recently virtual reality techniques (see Chapter 13). These techniques can be used either alone or in conjunction with medications to achieve an acceptable level of comfort for the burn patient (Hansen, Gauld, Wathen, et al., 2008).

Nutritional Support

Burn injuries produce profound metabolic abnormalities fueled by the exaggerated stress response to the injury. The body's response has been classified as hyperdynamic, hypermetabolic, and hypercatabolic. Hypermetabolism can affect morbidity and mortality by increasing the risk for infection and slowing the healing rate. Patients' metabolic demands vary with the extent of the burn injury and age (Demling, 2005b). Hypermetabolism is evident immediately after a burn injury. The degree of the response depends on the size of the burn and the patient's age, body composition, size, and genetic response to insult (Jeschke, Chinkes, Finnerty, et al., 2008). Persistent hypermetabolism may last up to 1 year after burn injury.

Major metabolic abnormalities after a burn injury include increased catabolic hormones (cortisol and catechols); decreased anabolic hormones (human growth factor and testosterone); a marked increase in the metabolic rate; a sustained increase in body temperature; a marked increase in glucose demands; rapid skeletal muscle breakdown with amino acids serving as the energy source; lack of ketosis, indicating that fat is not a major source of calories; and catabolism that does not respond to nutrient intake (Pereira, Murphy & Herndon, 2005). Therefore, it is essential to control the stress response by increasing the anabolic process through adequate nutrition and increased muscle activity, decreasing heat loss from wounds, and maintaining a warm environment. Controlling secondary stressors, such as pain and anxiety, also helps control the stress response.

The most important nutritional intervention is to provide energy and nutrients for prevention of infection and promotion of wound healing (Wolfe, 2007). Healing of the burn wound consumes large quantities of energy. Patients with burns greater than 40% TBSA have resting metabolic rates twice that of normal (Pereira, et al., 2005). Effective nutrition management depends on how well the energy

expenditure due to the burn injury can be estimated and matched with appropriate amounts of micronutrients, carbohydrates, lipids, and protein. The nutritional support required is based on the patient's preburn status and the TBSA burned.

Several formulas exist for estimating the daily metabolic expenditure and caloric requirements of patients with burn injuries. The most commonly used formulas are the Harris-Benedict equation, which determines basal energy requirements based on activity and burn size, Ireton-Jones formula, and the Modified Schoefield (Masters & Wood, 2008). Protein requirements may range from 2.0 to 3.0 g of protein per kilogram of body weight every 24 hours, which is 15% to 25% of the caloric intake. Although variation exists, most burn centers use a low fat and high carbohydrate enteral feeding, approximately 55% to 85% carbohydrate and 3% to 20% fat. Carbohydrates are included to meet caloric requirements and to spare protein, which is essential for wound healing. The patient may also receive added vitamins and minerals in excess of the normal requirements (Masters & Wood, 2008).

Feeding usually begins immediately or at least within 24 to 72 hours postburn injury. Nutrition can be administered either by the enteral or parenteral route, or a combination of both. The goal is to reach the patient's nutritional needs, which are usually in proportion to the burn size. These feedings are continued until the patient can adequately consume the recommended daily requirements by mouth (Wolfe, 2007). When the oral route is used, high-protein, high-calorie meals and supplements are given. Dietary consultations are useful in helping patients meet their nutritional needs. Daily calorie counts aid in assessing the adequacy of nutritional intake.

Patients lose a great deal of weight during recovery from severe burns. Reserve fat deposits are catabolized, fluids are lost, and caloric intake may be limited. Because a burn injury decreases the patient's resistance to infection and disease, the nutritional status must be improved and maintained even though the patient has a poor appetite and is weak. One goal of nutrition management is to decrease or stop the catabolic process and promote protein anabolism.

In addition, research is focused on aggressive alteration of the hyperglycemic response and administration of insulin therapy to promote wound healing. Other treatment modalities include early excision and skin grafting of the burn wound, aggressive prevention or treatment of infections, and adequate exercise with physical therapy to lessen muscle wasting and increase strength. Additional pharmacologic modalities used to alter the hypermetabolic state of burn injury include the use of oxandrolone (Oxandrin), an anabolic steroid; an adrenergic antagonist (propranolol [Indural]); and the anabolic protein, recombinant human growth hormone (Pereira, et al., 2005).

Indications for parenteral nutrition include weight loss greater than 10% of normal body weight, inadequate intake of enteral nutrition due to clinical status, prolonged wound exposure, and malnutrition or debilitated condition before injury. The risk of infection at the site of the central venous catheter required for parenteral nutrition must be considered.

Nursing Management

Continued assessment of the patient during the early weeks after the burn injury focuses on hemodynamic alterations, wound healing, pain and psychosocial responses, and early detection of complications. Assessment of respiratory and fluid status remains the highest priority for detection of potential complications.

The nurse assesses vital signs frequently. Continued assessment of peripheral pulses is essential for the first few postburn days while edema continues to increase, potentially damaging peripheral nerves and restricting blood flow. Close observation of the hourly fluid intake and urinary output as well as blood pressure and cardiac rhythm is essential during this phase and changes should be reported to the burn surgeon promptly.

The patient with an inhalation injury will require regular monitoring of level of consciousness, pulmonary function, and ability to ventilate. When inadequate ventilation and airway edema require the patient to be intubated and placed on a ventilator, frequent suctioning and assessment of the airway are priorities.

Restoring Normal Fluid Balance

To reduce the risk of fluid overload and consequent heart failure and pulmonary edema, the nurse closely monitors IV and oral fluid intake, using IV infusion pumps to minimize the risk of rapid fluid infusion. To monitor changes in fluid status, careful intake and output and daily weights are obtained. Changes, including those of blood pressure and pulse rate, are reported to the physician (invasive hemodynamic monitoring is avoided because of the high risk of infection).

Preventing Infection

A major part of the nurse's role during the acute phase of burn care is detection and prevention of infection. The nurse is responsible for providing a clean and safe environment and for closely scrutinizing the burn wound to detect early signs of infection. Culture results and white blood cell counts are monitored.

Aseptic technique is used for wound care procedures. Sterile technique is used for any invasive procedures, such as insertion of IV lines and urinary catheters or tracheal suctioning. Meticulous hand hygiene before and after each patient contact is also an essential component of preventing infection, even though gloves are worn to provide care.

The nurse protects the patient from sources of contamination, including other patients, staff members, visitors, and equipment. Invasive lines and tubing must be routinely changed according to recommendations of the CDC. Tube feeding reservoirs, ventilator circuits, and drainage containers are replaced regularly. Fresh flowers, plants, and fresh fruit baskets are not permitted in the patient's room because of the risk of microorganism growth. Visitors are screened to avoid exposure of the immunocompromised patient to pathogens.

Patients can inadvertently promote migration of microorganisms from one burned area to another by touching their wounds or dressings. Bed linens also can spread infection through either colonization with wound microorgan-

isms or fecal contamination. Regular bathing of unburned areas and changing of linens can help prevent infection.

Maintaining Adequate Nutrition

Oral fluids should be initiated slowly after bowel sounds resume. The patient's tolerance is recorded. If vomiting and distention do not occur, fluids may be increased gradually and the patient may be advanced to a normal diet or to tube feedings.

The nurse collaborates with the dietitian or nutrition support team to plan a protein- and calorie-rich diet that is acceptable to the patient. Family members may be encouraged to bring nutritious and favorite foods to the hospital. High-calorie nutritional supplements such as Ensure and Resource may be provided. Caloric intake must be documented. Vitamin and mineral supplements may be prescribed.

If caloric goals cannot be met by oral feeding, a feeding tube is inserted and used for continuous or bolus feedings of specific formulas. The volume of residual gastric secretions should be checked to ensure absorption.

The patient should be weighed each day and the results graphed. The patient can use this information to set goals for nutritional intake and to monitor weight loss and gain. Ideally, the patient will lose no more than 5% of preburn weight if aggressive nutritional management is implemented.

Promoting Skin Integrity

Wound care is usually the single most time-consuming element of burn care after the emergent phase. The physician prescribes the desired topical antibacterial agents and specific biologic, biosynthetic, or synthetic wound coverings and plans for surgical excision and grafting. The nurse needs to make astute assessments of wound status, use creative approaches to wound dressing, and support the patient during the emotionally distressing and very painful experience of wound care.

Assessment of the burn wound requires an experienced eye, hand, and sense of smell. Important wound assessment features include size, color, odor, eschar, exudate, epithelial buds (small pearl-like clusters of cells on the wound surface), bleeding, granulation tissue, the status of graft take, healing of the donor site, and the condition of the surrounding skin. Any significant changes in the wound are reported to the physician because they usually indicate burn infection and require immediate intervention.

A diagram, updated daily by the nurse responsible for the patient's care, helps inform all those concerned about the latest wound care procedures in use for the patient.

The nurse also assists the patient and family by providing instruction, support, and encouragement to take an active part in dressing changes and wound care when appropriate. Discharge planning needs for wound care are anticipated early in the course of burn management, and the strengths of the patient and family are assessed and used in preparing for the patient's eventual discharge and home care.

Relieving Pain and Discomfort

Pain measures are continued during the acute phase of burn recovery. Analgesic agents and anxiolytic medications are administered as prescribed. Frequent assessment of pain and discomfort is essential. To increase its effectiveness, analgesic medication is provided before the pain becomes severe. Nursing interventions such as teaching the patient relaxation techniques, giving the patient some control over wound care and analgesia, and providing frequent reassurance are helpful. Guided imagery and distraction (eg, video programs or video games) can be used to alter the patient's perceptions of and responses to pain. Other pain-relieving approaches include hypnosis, music therapy, and virtual reality.

The nurse assesses the patient's sleep patterns daily. Lack of sleep and rest interferes with healing, comfort, and restoration of energy. If necessary, sedatives are prescribed on a regular basis in addition to analgesics and anxiolytics.

The nurse works quickly to complete treatments and dressing changes to reduce pain and discomfort. The patient is encouraged to take analgesic medications before painful procedures. The patient's response to the medication and other interventions is assessed and documented.

Healing burn wounds are typically described by patients as itchy and tight. Oral antipruritic agents, a cool environment, frequent lubrication of the skin with water or a silica-based lotion, exercise and splinting to prevent skin contracture, and diversional activities all help promote comfort in this phase.

Promoting Physical Mobility

An early priority is to prevent complications of immobility. Deep breathing, turning, and proper positioning are essential nursing practices that prevent atelectasis and pneumonia, control edema, and prevent pressure ulcers and contractures. These interventions are modified to meet the patient's needs. Low-air-loss and rotation beds may be useful, and early sitting and ambulation are encouraged. If the lower extremities are burned, elastic pressure bandages should be applied before the patient is placed in an upright position. These bandages promote venous return and minimize edema formation. Prevention of deep vein thrombosis (DVT) is an important factor in care. Patients with burn injuries are at high risk because of their hypercoagulability, loss of vascular integrity, immobility, multiple invasive lines and need for other operative procedures. In fact, there is a 1% to 23% incidence of DVT in burn patients documented. There is cautious use of heparin due to the bleeding potential; however, most burn centers use prophylactic therapy including sequential graduated compression devices in the high-risk groups (Faucher & Conlon, 2007).

The burn wound is in a dynamic state for at least 1 year after wound closure. During this time, aggressive efforts must be made to prevent contracture and hypertrophic scarring. Both passive and active range-of-motion exercises are initiated from the day of admission and are continued after grafting, within prescribed limitations. Splints or functional devices may be applied to the extremities for contracture control. The nurse monitors the splinted areas for signs of vascular insufficiency, nerve compression, and skin breakdown. Occupational and physical therapists are consulted to develop a patient-specific plan of care throughout hospitalization and recovery.

Strengthening Coping Strategies

In the acute phase of burn care, the patient is facing the reality of the burn injury and is grieving over obvious losses. Depression, anger, regression, and manipulative behavior

are common responses of patients who have burn injuries. Withdrawal from participation in required treatments and regression must be viewed with an understanding that such behavior may help the patient cope with an enormously stressful event. Although most patients recover emotionally from a burn injury, some have more difficult psychological reactions to the injury and its outcomes (Kildal, Willebrand, Andersson, et al., 2004). There is evidence that psychological distress and depression are common in people who have experienced burns; however, more studies are needed in this area (Fauerbach, Pruzinsky & Saxe, 2007).

Difficulty coping along with other psychological stressors often limits the patient's physical and psychological recovery (Fauerbach, Lezotte, Hills, et al., 2005). Patients who experience a burn injury tend to have high rates of involvement in risky behaviors (eg, alcohol and substance abuse, depression) before the injury (Appleby, 2005). Intrusive thoughts of the burn event and reliving it over and over may also occur and can indicate posttraumatic stress disorder (PTSD).

Much of the patient's energy goes into maintaining vital physical functions and wound healing in the early postburn weeks, leaving little emotional energy for coping in a more effective manner. The nurse can assist the patient to develop effective coping strategies by setting specific expectations for behavior, promoting truthful communication to build trust, helping the patient practice appropriate strategies, and giving positive reinforcement when appropriate.

The patient frequently vents feelings of anger. At times the anger may be directed inward because of a sense of guilt, perhaps for causing the fire or even for surviving when loved ones perished. The anger may be directed outward toward those who escaped unharmed or toward those who are now providing care. One way to help the patient handle these emotions is to enlist someone to whom the patient can vent feelings without fear of retaliation. A nurse, social worker, psychiatric liaison nurse, or spiritual advisor or counselor who is not involved in direct care activities may fill this role successfully.

Patients with burn injuries are very dependent on health care team members during the long period of treatment and recovery. However, even when physically unable to contribute much to self-care, they should be included in decisions regarding care and encouraged to assert their individuality in terms of preferences and recognition of their unique identities. As the patient improves in mobility and strength, the nurse works with the patient to set realistic expectations for self-care, including self-feeding, assistance with wound care procedures, exercise, and planning for the future. Many patients respond positively to the use of contractual agreements and other strategies that recognize their independence and their specific role as part of the health care team moving toward the goal of self-care. Consultation with psychiatric/mental health care providers may be helpful to assist the patient in developing effective coping strategies.

Supporting Patient and Family Processes

Family functioning is disrupted with burn injury. One of the nurse's responsibilities is to support the patient and family and to address their spoken and unspoken concerns. Family members need to be instructed about ways that they can support the patient as adaptation to burn trauma occurs. The family also needs support from the health care team. The burn injury has tremendous psychological, economic, and practical impact on the patient and family. Referrals for social services or psychological counseling should be made as appropriate. This support continues into the rehabilitation phase. Some burn centers offer a peer support program that involves a burn survivor visiting the patient while hospitalized to provide support. Many survivors enjoy the opportunity to help others through this experience.

Patients who experience major burns are commonly sent to burn centers far from home. Because burn injuries are sudden and unexpected, family roles are disrupted. Therefore, both the patient and the family need thorough information about the patient's burn care and expected course of treatment. Patient and family education begins at the initiation of burn management. Barriers to learning are assessed and considered in teaching. The preferred learning styles of both the patient and family are assessed. This information is used to tailor teaching activities. The nurse assesses the ability of the patient and family to grasp and cope with the information. Verbal information is supplemented with videos, models, or printed materials if available. Patient and family education is a priority in the acute and rehabilitation phases.

Nurses must remain sensitive to the possibility of changing family dynamics. It is not unusual for the provider in the family to be the one who is injured. Roles begin to change, which adds more stress to the family. In addition, families are often relocated due to loss of property from the fire. Social services play an integral part in providing support at this time.

Monitoring and Managing Potential Complications

Heart Failure and Pulmonary Edema

The patient is assessed for fluid overload, which may occur as fluid is mobilized from the interstitial compartment back into the intravascular compartment. If the cardiac and renal systems cannot compensate for the excess vascular volume, heart failure and pulmonary edema may result. The patient is assessed for signs of heart failure, including decreased cardiac output, oliguria, jugular vein distention, edema, and the onset of an S_3 or S_4 heart sound. If invasive hemodynamic monitoring is used, increasing central venous, pulmonary artery, and wedge pressures indicate increased fluid volume.

Crackles in the lungs and increased difficulty with respiration may indicate a fluid buildup in the lungs, which is reported promptly to the physician. In the meantime, the patient is positioned comfortably, with the head of the bed raised (if not contraindicated because of other treatments or injuries) to promote lung expansion and gas exchange. Management of this complication includes providing supplemental oxygen, administering IV diuretic agents, carefully assessing the patient's response, and providing vasoactive medications, if indicated.

Sepsis

The signs of early systemic sepsis are subtle and require a high index of suspicion and very close monitoring of changes in the patient's status. Early signs of sepsis may include increased temperature, increased pulse rate,

widened pulse pressure, and flushed dry skin in unburned areas. As with many observations of the patient with a burn injury, one needs to look for patterns or trends in the data. (See Chapter 15 for a more detailed discussion of septic shock.)

Wound and blood cultures are performed as prescribed, and results are reported to the physician immediately. The nurse also observes for and reports early signs of sepsis and promptly intervenes, administering prescribed IV fluids and antibiotics to prevent septic shock, a complication with a high mortality rate. Antibiotics must be administered as scheduled to maintain proper blood concentrations. Serum antibiotic levels are monitored for evidence of maximal effectiveness, and the patient is monitored for toxic side effects.

Acute Respiratory Failure and Acute Respiratory Distress Syndrome

The patient's respiratory status is monitored closely for increased difficulty in breathing, change in respiratory pattern, or onset of adventitious (abnormal) sounds. Typically, at this stage, signs and symptoms of injury to the respiratory tract become apparent. Respiratory failure may follow. As described previously, signs of hypoxia (decreased oxygen to the tissues), decreased breath sounds, wheezing, tachypnea, stridor, and sputum tinged with soot (or in some cases containing sloughed tracheal tissue) are among the many possible findings. Patients receiving mechanical ventilation must be assessed for a decrease in tidal volume and lung compliance. The key sign of the onset of ARDS is hypoxemia while receiving 100% oxygen, with decreased lung compliance and significant shunting. The physician should be notified immediately of deteriorating respiratory status.

Medical management of the patient with acute respiratory failure requires intubation and mechanical ventilation (if not already in use). If ARDS has developed, higher oxygen levels, positive end-expiratory pressure, and pressure support are used with mechanical ventilation to promote gas exchange across the alveolar–capillary membrane (see Chapter 25).

Visceral Damage. The nurse must be alert to signs of necrosis of visceral organs due to electrical injury. Tissues affected are usually located between the entrance and exit wounds of the electrical burn. All patients with electrical burns should undergo cardiac monitoring, with dysrhythmias being reported to the physician. Careful attention must also be paid to signs or reports of pain related to deep muscle ischemia. To minimize the severity of complications, visceral ischemia must be detected as early as possible. In the operating room, the burn surgeon may perform **fasciotomies** to relieve the swelling and ischemia in the muscles and fascia and to promote oxygenation of the injured tissues. Because of the deep incisions involved with fasciotomies, the patient must be monitored carefully for signs of excessive blood loss and hypovolemia.

Gerontologic Considerations

In elderly patients, a careful history of preburn medications and preexisting illnesses is essential. Nursing assessment of the elderly patient with burns should include particular attention to pulmonary function, response to fluid resuscitation, and signs of mental confusion or disorientation. Fever may be absent in the presence of complications such as sepsis. Therefore, surveillance for other signs of infection becomes even more important. Nursing care of the elderly patient with burn injuries promotes early mobilization, aggressive pulmonary care, and attention to preventing complications.

REHABILITATION PHASE

Rehabilitation begins immediately after the burn has occurred and often extends for years after injury. The emphasis on early rehabilitation cannot be overestimated. In this final phase of care, the focus becomes rehabilitation, reconstruction, and reintegration of the burn survivor (Sheridan, 2007b). In addition, the burn team focuses on late complications (Table 57-6).

Burn rehabilitation is time-consuming and challenging and is very specific to the severity and location of injury as well as the patient's needs and goals. These goals vary based on phase of care and need to be addressed frequently to ensure constant progress. During hospitalization the goals include maintaining range of motion (ROM), preventing contractures through splinting techniques, decreasing edema, and the preventing skin breakdown through proper positioning. As the acute phase comes to a close, patients become more aware of their injuries and the challenges they face. The goals are functional and aimed at activities of daily living such as ambulation and participation in self-care as well as scar management and returning to work or school (Chart 57-6). Occupational and physical therapists are essential to optimizing patient goals and outcomes (Sheridan, 2007b).

Psychological Support

A patient's outlook, motivation, and support system are important to his or her overall well-being and ability to progress through the rehabilitation phase. There are three basic phases of psychological recovery from a burn injury. During the critical phase, patients often are confused from medication they are taking, but they have an underlying sense of fear, anxiety, and pain. In the acute phase, patients recognize that survival is expected. They have periods of depression due to their awareness of the functional and body image challenges ahead and can recognize all they have lost. Thirty percent of burn patients develop some form of PTSD. The symptoms and psychological responses to traumatic events including PTSD are discussed further in Chapter 7.

The final stage of psychological recovery occurs within 1 to 2 years following discharge. This is an emotional time as the patient and family begin to live with new physical limitations and challenges in relationships. The role of various team members and the support from peer burn survivors during this time cannot be understated (Sheridan, 2007b).

Psychological treatment plans should include a full assessment of these issues and a targeted plan with the appropriate resources to promote the patient's social and vocational reintegration and improved quality of life (Wallis, Renneberg, Ripper, et al., 2006). Burn injuries can have a major impact

Table 57-6 COMPLICATIONS IN REHABILITATION PHASE OF BURN CARE

Complications	Contributing Factors	Interventions
Neuropathies, peripheral neuropathies, mononeuropathies, multimononeuropathies, nerve entrapment	Electrical injury, large deep burns, improper positioning, edema, scar tissue	Assess peripheral pulses and sensation (neurovascular checks). Prevent edema and pressure by elevation, positioning, and prevention of constricting dressings. Assess splints for proper fit and application. Consult occupational therapy (OT) and physical therapy (PT) for positioning.
Heterotopic ossification (abnormal formation of bone in response to soft tissue trauma)	Prolonged immobility	Perform gentle range-of-motion exercises.
Hypertrophic scarring	Partial-thickness and full-thickness burns	Keep skin pliable and soft. Apply pressure garments as prescribed. Massage.
Contractures	Partial-thickness and full-thickness burns	Maintain position of joints in alignment. Perform gentle range of motion exercises. Consult OT and PT for exercises and positioning recommendations.
Wound breakdown	Shearing, pressure, inadequate nutrition	Teach patient about importance of good nutrition. Protect wound from pressure and shearing forces.
Gait deviations	Pain, burn wound, donor site, scarring of joints, electrical injury of the brain	Provide adequate pain management. Consult OT and PT. Promote ambulation and mobility training.
Complex regional pain syndrome (previous reflex sympathetic dystrophy [RSD])	Trauma and burns	Provide adequate pain management. Consult OT and PT for exercises. Promote gentle motion of affected extremities.
Joint instability	Burn wound, burn scar and contractures	Maintain joint through appropriate application of splints. Monitor joint pinning if indicated. Consult OT and PT.

on quality of life. Changes in physical activity as well as social and psychological adjustments, such as returning to school and employment status, may be challenging. It is important throughout this process to assess and address the family needs. When one member of a family sustains a major burn injury, the entire family is affected. Separation, feelings of helplessness, loss, and psychological dysfunction may be experienced in varying degrees. Family and friends need support, education, and guidance in assisting the patient to return to their optimal health (Ceranoglu & Stern, 2006).

CHART 57-6 NURSING RESEARCH PROFILE *Life After Burn Injury*

Moi, A. L. & Gjengedal, E. (2008). Life after burn injury: Striving for regained freedom. *Qualitative Health Research, 18*(12), 1621–1630.

Purpose

Second only to the patient's survival, the priority of burn care today is optimal quality of life of survivors. The purpose of this study was to identify and describe the meaning of the experience of life after major burn injury.

Design

This qualitative study used a phenomenological perspective to describe and explore the meaning that 14 people who survived severe burn injury attributed to the experience. They were recruited from an outpatient clinic at a burn center in Norway. The researchers intentionally recruited participants of both genders (men = 11, women = 4), across a wide age range (19 to 74, with mean age of 46 years), who had experienced different types of burns (flames = 9, electrical injury = 3, scalding = 2), and received different treatments of their burns. In-depth unstructured interviews were conducted 10 to 35 months after the burn injury; the interviews were audiotaped, transcribed, and analyzed using Giorgi's phenomenological method.

Findings

The major finding was the effort on the part of participants to regain freedom that included reduced or absent bodily or social restrictions and a meaningful life that was the same as or better than before the injury occurred. The experiences described as supporting this goal included (1) facing the extreme and trying to restore order and minimize damage, (2) having a disrupted life history with the loss of memory that occurred during the immediate postburn period, (3) accepting the unchangeable, and (4) changing what could be changed. Some participants indicated that experiencing and surviving their injury gave them a new view of life and made their lives richer.

Nursing Implications

The experience of surviving a severe burn injury is life-altering. The researchers suggest that patients should be given the opportunity to tell their stories and to express their views. Positive feelings and growth on the part of patients should be recognized by burn-care staff, particularly during the later phases of burn care. Patients should be encouraged to share their experiences and views. The researchers also suggest that patients and families be provided with information about what to expect as they move through the phases of burn care.

Abnormal Wound Healing

Partial-thickness wounds involving the epidermis and superficial dermis tend to heal without scarring. However, deep partial-thickness and full-thickness wounds involving the dermis and subcutaneous tissue heal with varying degrees of scarring due to abnormal healing (Arnt, Dover & Alam, 2006).

Normal scarring occurs in a superficial tissue injury and begins forming within 7 to 10 days postinjury and progresses over the next 6 to 12 months. Abnormal scarring occurs after a longer period of wound healing and forms either hypertrophic or keloid scars.

Hypertrophic and Keloid Scars

Hypertrophic scars form within the boundaries of the initial wound and push outward on the perimeter of the wound. They are common in areas over joints and in the younger population. These scars may be hypopigmented or hyperpigmented (Arnt, et al., 2006).

The scar becomes red (because of its hypervascular nature), raised, and hard. A keloid is an irregularly formed scar that extends beyond the margins of the original wound. They are large, nodular, and ropelike, often causing itching and tenderness. They are more common in dark pigmented skin, uncommon in children and the elderly, and have familial tendencies. Scars occur in all forms and arise in different areas, making some more undesirable than others. Therefore, prevention and treatment is individualized to the patient's needs (Arnt, et al., 2006).

Prevention and Treatment of Scars

Treatment modalities that are theoretically based on wound healing and scar formation are used to prevent scar contractures and excess hypertrophic tissue. Compression is introduced early in burn wound treatment. Elastic bandage wraps are used initially to help promote adequate circulation, but they can also be used as the first form of compression followed by elasticized tubular bandage until the patient can be measured for a customized garment (Fig. 57-7). Tools of therapy include pressure, use of topical silicone, scar massage, and steroid injections (Sheridan, 2007b). Application of elastic pressure garments loosens collagen bundles and encourages parallel orientation of the collagen to the skin surface. As pressure continues over time, there is a restructuring of the collagen and a decrease in vascularity and cellularity. Although this therapy is somewhat controversial, pressure has shown to be beneficial in controlling scar formation over time. Garments are worn continuously (ie, 23 hours a day). Many areas of the body are difficult to compress due to the contours or location of the injury. Silicone sheets are helpful for these small troublesome areas and are placed beneath the garment to enhance scar compression. Gentle superficial scar massage can be performed with a moisturizer several times a day. This is helpful in smaller areas and is convenient for the patient. The use of steroid injections into the scar may be helpful in areas of scar development, but they are difficult and painful. Pruritus is a common discomfort in the healed burn wound and can last up to 6 months after healing has occurred. It is treated with moisturizers, massage, oral and topical antihistamines, and topical compresses or baths. This is a troublesome part of recovery and requires further research (Sheridan, 2007b).

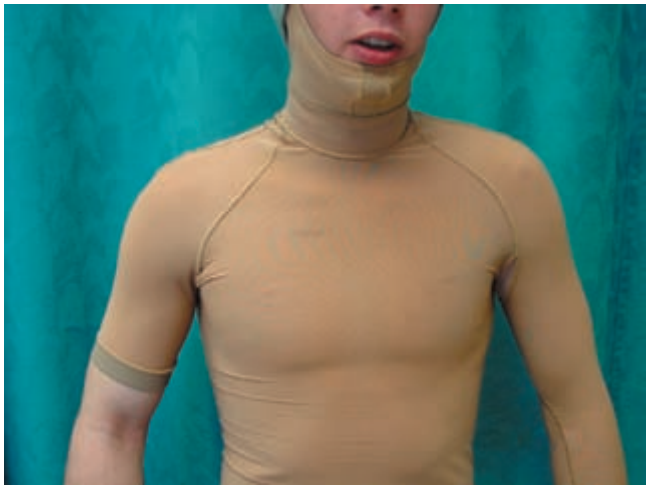

Figure 57-7 Pressure garments. Application of pressure garments helps prevent hypertrophic burn scarring. Used with permission of Jobst Institute, Inc., Toledo, OH.

Burn reconstruction is a treatment option after all scars have matured and is discussed within the first few years after injury. This decision requires individualized planning, realistic expectations, and patience. The procedures utilized by the surgeon include contracture release and skin grafting, use of tissue expansion, and skin flaps to cover or reconstruct the defect area (Sheridan, 2007b).

NURSING PROCESS

Care of the Patient During the Rehabilitation Phase

Assessment

The nurse obtains information about the patient's education level, occupation, leisure activities, cultural background, religion, and family interactions early. The patient's self-concept, mental status, emotional response to the injury and hospitalization, level of intellectual functioning, previous hospitalizations, response to pain and pain relief measures, and sleep pattern are also essential components of a comprehensive assessment. Information about the patient's general self-concept, self-esteem, and coping strategies in the past are valuable in addressing emotional needs.

Ongoing physical assessments related to rehabilitation goals include range of motion of affected joints, functional abilities in activities of daily living, early signs of skin breakdown from splints or positioning devices, evidence of neuropathies (neurologic damage), activity tolerance, and quality or condition of healing skin. The patient's participation in care and ability to demonstrate self-care in such areas as ambulation, eating, wound cleaning, and applying pressure wraps are documented on a regular basis. In addition to these assessment parameters, specific complications and treatments require additional specific assessments; for

example, the patient undergoing primary excision requires postoperative assessment.

Diagnosis

Nursing Diagnoses

Based on the assessment data, priority nursing diagnoses in the long-term rehabilitation phase of burn care may include the following:

- Activity intolerance related to pain on exercise, limited joint mobility, muscle wasting, and limited endurance
- Disturbed body image related to altered physical appearance and self-concept
- Deficient knowledge about postdischarge home care and recovery needs

Collaborative Problems/Potential Complications

Based on the assessment data, potential complications that may develop in the rehabilitation phase include:

- Contractures
- Inadequate psychological adaptation to burn injury

Planning and Goals

The major goals for the patient include increased participation in activities of daily living; increased understanding of the injury, treatment, and planned follow-up care; adaptation and adjustment to alterations in body image, self-concept, and lifestyle; and absence of complications.

Nursing Interventions

Promoting Activity Tolerance

Nursing interventions that must be carried out according to a strict regimen and the pain that accompanies movement take their toll on the patient. The patient may become confused and disoriented and lack the energy or motivation to participate optimally in care. The nurse must schedule care in such a way that the patient has periods of uninterrupted sleep. A good time for planned patient rest is after the stress of dressing changes and exercise, while pain interventions and sedatives are still effective. This plan must be communicated to family members and other care providers.

The patient may have insomnia related to frequent nightmares about the burn injury or to other fears and anxieties about the outcome of the injury. The nurse listens to and reassures the patient and administers hypnotic agents, as prescribed, to promote sleep.

Reducing metabolic stress by relieving pain, preventing chilling or fever, and promoting the physical integrity of all body systems help the patient conserve energy for therapeutic activities and wound healing.

The nurse incorporates physical therapy exercises in the patient's care to prevent muscle atrophy and to maintain the mobility required for daily activities. The patient's activity tolerance, strength, and endurance gradually increase if activity occurs over increasingly longer periods. Fatigue, fever, and pain tolerance are monitored and used to determine the amount of activity to be encouraged on a daily basis. Activities such as family visits and recreational or play therapy (eg, video games, radio, television) can provide diversion, improve the patient's outlook, and increase tolerance for physical activity. In elderly patients and those with chronic illnesses and disabilities, rehabilitation must take into account preexisting functional abilities and limitations.

Improving Body Image and Self-Concept

Patients who have survived burn injuries frequently suffer profound losses. These include not only a loss of body image due to disfigurement but also losses of personal property, homes, loved ones, and ability to work. They lack the benefit of anticipatory grief often seen in a patient who is approaching surgery or dealing with the terminal illness of a loved one.

As care progresses, the patient who is recovering from burns becomes aware of daily improvement and begins to exhibit basic concerns: Will I be disfigured or be disabled? How long will I be in the hospital? What about my job and family? Will I ever be independent again? How can I pay for my care? Was my burn the result of my carelessness?

As the patient expresses such concerns, the nurse must take time to listen and to provide realistic support. The nurse can refer the patient to a support group, such as those usually available at regional burn centers or through organizations such as the Phoenix Society (see Resources at the end of the chapter). Through participation in such groups, the patient will meet others with similar experiences and learn coping strategies to help him or her deal with losses. Interaction with other burn survivors allows the patient to see that adaptation to the burn injury is possible. If a support group is not available, visits from other survivors of burn injuries can be helpful to the patient coping with such a traumatic injury.

A major responsibility of the nurse is to constantly assess the patient's psychosocial reactions. Questions to consider include the following: What are the patient's fears and concerns? Does the patient fear loss of control of care, independence, or sanity itself? Is the patient afraid of rejection by family and loved ones? Does he or she fear being unable to cope with pain or physical appearance? Does the patient have concerns about sexuality, including sexual function? Being aware of these anxieties and understanding the basis of the patient's fears enable the nurse to provide support and to cooperate with other members of the health care team in developing a plan to help the patient deal with these feelings. Journaling can be helpful for patients to express themselves and track their progress with psychological healing.

When caring for a patient with a burn injury, the nurse needs to be aware that there are prejudices and misunderstandings in society about those who are viewed as different. Opportunities and accommodations available to others are often denied those who are disfigured. These include social participation, employment, prestige, various roles, and status. The health care team must actively promote a healthy body image and self-concept in patients with burn injuries so that they can accept or challenge others' perceptions of those who are disfigured or disabled. Survivors themselves must show others who they are, how they function, and how they want to be treated.

The nurse can help patients practice their responses to people who may stare or inquire about their injury once

they are discharged from the hospital. The nurse can help patients build self-esteem by recognizing their uniqueness—for example, with small gestures such as providing a birthday cake, combing the patient's hair before visiting hours, giving information about the availability of a cosmetician to enhance appearance, and teaching the patient ways to direct attention away from a disfigured body to the self within. Consultants such as psychologists, social workers, vocational counselors, and teachers are valuable participants in assisting burn patients to regain their self-esteem.

Monitoring and Managing Potential Complications

CONTRACTURES. With early and aggressive physical and occupational therapy, contractures are rarely a long-term complication. However, surgical intervention is indicated if a full range of motion in the burn patient is not achieved. (See Chapter 11 for a discussion of prevention of contractures.)

IMPAIRED PSYCHOLOGICAL ADAPTATION TO THE BURN INJURY. Some patients, particularly those with limited coping skills or psychological function or a history of psychiatric problems before the burn injury, may not achieve adequate psychological adaptation to the burn injury. Psychological counseling or psychiatric referral may be made to assess the patient's emotional status, to help the patient develop coping skills, and to intervene if major psychological issues or ineffective coping is identified.

Promoting Home and Community-Based Care

TEACHING PATIENTS SELF-CARE. As the inpatient phase of recovery becomes shorter, the focus of rehabilitative interventions is directed toward outpatient care, home care, or care in a rehabilitation center. Throughout the phases of burn care, efforts are made to prepare the patient and family for the care that will continue at home. They are instructed about the measures and procedures that they will need to perform. For example, patients commonly have small areas of clean, open wounds that are healing slowly. They are instructed to wash these areas daily with mild soap and water and to apply the prescribed topical agent or dressing.

In addition to instructions about wound care, patients and families require careful written and verbal instructions about pain management, nutrition, and prevention of complications. Information about specific exercises and use of pressure garments and splints is reviewed with both the patient and the family, and written instructions are provided for their use at home. The patient and family are taught to recognize abnormal signs and report them to the physician. The patient and family are assisted in planning for the patient's continued care by identifying and acquiring supplies and equipment that are needed at home (Chart 57-7).

CONTINUING CARE. Follow-up care after discharge by the multidisciplinary team is necessary. Patients who receive care in a burn center usually return to the burn clinic or center periodically for evaluation by the burn team, modification of home care instructions, and planning for reconstructive surgery. Other patients receive ongoing care from the burn surgeon who cared for them during the acute phase of their management. Still other patients require the services of a rehabilitation center and may be transferred to such a center for aggressive rehabilitation before going home. Many patients require outpatient physical or occupational therapy, often several times weekly. It is often the nurse who is responsible for coordinating all aspects of care and ensuring that the patient's needs are met. Such coordination is an important aspect of assisting the patient to achieve independence.

Patients who return home after a severe burn injury, those who cannot manage their own burn care, and those with inadequate support systems need referral for home care. During visits to the patient at home, the home care nurse assesses the patient's physical and psychological status as well as the adequacy of the home setting for safe and adequate care. The nurse monitors the patient's progress and adherence to the plan of care and notes any problems that interfere with the patient's ability to carry out the care. During the visit, the nurse assists the patient and family with wound care and exercises. Patients with severe or persistent depression or difficulty adjusting to changes in their social or occupational roles are identified and referred to the burn team for possible referral to a psychologist, psychiatrist, or vocational counselor.

The burn team or home care nurse identifies community resources that may be helpful for the patient and family. Several burn patient support groups and other organizations throughout the United States offer services for burn survivors. They provide contact with caring people (often people who have themselves recovered from burn injuries) who can visit the patient in the hospital or home or telephone the patient and family periodically to provide support and counseling about skin care, cosmetics, and problems related to psychosocial adjustment. Such organizations, and many regional burn centers, sponsor group meetings and social functions at which outpatients are welcome. Some also provide reentry programs or burn retreats and are active in burn prevention activities.

Evaluation

Expected Patient Outcomes

Expected patient outcomes may include the following:

1. Demonstrates activity tolerance required for desired daily activities
   a. Obtains adequate sleep daily
   b. Reports absence of nightmares or sleep disturbances
   c. Shows gradually increasing tolerance and endurance in physical activities
   d. Can concentrate during conversations
   e. Has energy available to sustain desired daily activities
2. Adapts to altered body image
   a. Verbalizes accurate description of alterations in body image and accepts physical appearance
   b. Demonstrates interest in resources that may improve body appearance and function
   c. Uses cosmetics, wigs, and prostheses as desired to achieve acceptable appearance
   d. Socializes with significant others, peers, and usual social group

CHART 57-7

HOME CARE CHECKLIST
The Patient With a Burn Injury

At the completion of the home care instruction, the patient or caregiver will be able to:	PATIENT	CAREGIVER
Mental Health		
Identify strategies to promote own mental health; for example:		
• Remember that changes in lifestyle take time.	✔	✔
• Resume previous interests and activities gradually.	✔	
• Take one day at a time to regain physical and mental strength.	✔	
• Be aware of own feelings and fears and discuss them with selected others.	✔	✔
• Expect concerns, frustrations, and depression about changes in appearance.	✔	✔
• Be honest with self, family, and friends about needs, hopes, and fears.	✔	✔
• Realize that emotional adjustment to the burn injury will occur with time.	✔	✔
Burn Skin Precautions and Wound Care		
Identify the following skin precautions and wound care:		
• Wear sun block with the highest SPF possible to protect burned skin from the sun.	✔	
• Avoid further trauma to burned skin; leave unbroken blisters that may form.	✔	✔
• Lubricate healed burned skin with mild lotion (as prescribed); avoid scratching.	✔	
• Wear wide-brimmed hats if face has been burned to protect the area from the sun.	✔	
• Use only mild soap and lotion (ie, products without perfume) on burned areas.	✔	✔
Exercise		
Describe the following guidelines for exercise:		
• Do as much for self as possible.	✔	
• Adhere to the exercise regimen given by the therapist.	✔	
• Participate in exercise every day, several times a day, even when "not feeling like it."	✔	
Nutrition		
Identify the following guidelines for nutrition:		
• Eat a diet high in calories and protein.	✔	
• Drink adequate volume of fluids to prevent constipation associated with use of analgesic medications.	✔	
Pain Management		
Describe the following steps for managing pain:		
• Avoid situations that require alertness (analgesic agents may produce drowsiness).	✔	
• Take analgesic medication as prescribed (30 minutes before painful procedures such as dressing changes).	✔	
• Use relaxation and distraction to relieve pain and discomfort.	✔	
Thermoregulation		
Identify strategies to compensate for inability to regulate body temperature:		
• Dress to accommodate cold and hot weather or environment.	✔	
• Avoid extremes of temperature.	✔	

CHART 57-7 HOME CARE CHECKLIST

The Patient With a Burn Injury (Continued)

	PATIENT	CAREGIVER
Clothing Considerations		
State the following strategies in selection of clothing to wear:		
• Avoid tight clothing over burned areas.	✔	
• Select white cotton, loose-fitting clothing so that dyes in colored clothes do not irritate healing skin.	✔	
• Wear clothing and gloves to protect healing skin from unnecessary bruises, bumps, and scratches.	✔	
Management of Burn Scar		
Describe the following strategies to manage burn scar:		
• Massage and stretch skin to maintain/increase its elasticity.	✔	✔
• Use lotion for massage as recommended by therapist.	✔	✔
• Wear compression garments 23 hours a day.	✔	
Resumption of Sexual Relations		
Identify the following guidelines regarding resumption of sexual relationships:		
• Realize that resumption of sexual relationships is the rule rather than the exception.	✔	✔
• Expect sensitivity of and around the genital area for several months if these areas were burned.	✔	
• Resume sexual activity slowly; endurance will increase with time.	✔	

Adapted with permission from Orlando Regional Medical Center Burn Unit's Personal Guide to Burn Care.

e. Seeks and achieves return to role in family, school, and community as a contributing member

3. Demonstrates knowledge of required self-care and follow-up care
   a. Describes surgical procedures and treatments accurately
   b. Verbalizes detailed plan for follow-up care
   c. Demonstrates ability to perform wound care and prescribed exercises
   d. Returns for follow-up appointments as scheduled
   e. Identifies resource people and agencies to contact for specific problems
4. Exhibits no complications
   a. Demonstrates full range of motion
   b. Shows no signs of withdrawal or depression
   c. Displays no psychotic behaviors

Outpatient Burn Care

Increasing numbers of patients receive treatment of burns in outpatient settings in an effort to coordinate specific burn care needs and to decrease healthcare costs and length of hospitalization. The increased availability of outpatient surgery and access to expert burn care in outpatient settings make this option possible for the treatment of minor burn care as well as a destination for the discharged burn patient.

The goals for treatment in an outpatient setting may include burn wound management, pain management, scar and reconstructive care, and rehabilitation. However, a number of factors must be considered in determining if outpatient care is appropriate for the patient: age, past medical history, the extent and depth of the burn, location of the burn wounds, the availability of family support systems and community resources, the patient's compliance and the distance from home, and availability of transportation from home to the outpatient setting.

The frequency of follow-up visits is individualized and based on these factors. The initial outpatient visit for a discharged burn patient is usually scheduled within 2 or 3 days after hospital discharge and then biweekly until there is evidence of a successful outcome. After healing has occurred, appointments are monthly and eventually every 4 to 6 weeks for continued assessment of pain, physical limitations, and scar maturation. Patient and family education is very important and should include verbal and written instructions as well as return demonstration of the burn or scar care required. These include the wound treatment, pain management, treatment for itching, provision of adequate nutrition, and promotion of exercise and rest. Instruction is also provided about the signs and symptoms of infection that should be reported to the burn team. The importance of notifying the outpatient setting about early complications and of keeping follow-up appointments is emphasized to the patient and family. Physical therapy and occupational therapy are often provided in the outpatient

burn setting. The rehabilitation goals are to increase range of motion and to strengthen and build the patient's endurance. This is accomplished with a specific plan of care and includes routine visits for up to 2 years following the injury. Adaptation to lifestyle changes and emotional status should be assessed during the outpatient visits and proper referrals made for counseling services. These assessments are difficult to recognize due to the infrequent nature of the visits, and, therefore, it is helpful to incorporate family response and interactions into the assessment. The health care team must also be alert to issues of substance abuse, safety concerns, suicidal thoughts, depression, and PTSD.

CRITICAL THINKING EXERCISES

1 A 35-year-old woman was scalded in the bathtub, where she sustained 40% full-thickness burns to her lower legs, right arm, and back. It is not known how long the woman was in the tub. She apparently had a seizure while showering and fell onto the hot water faucet. On admission to the emergency department, the woman's temperature is 35.5°C (94°F) and her weight is 111 lb (50 kg). She has diabetes as well as a history of uncontrolled seizure activity. What are the priorities in her medical and nursing care during the emergent phase of burn care? What assessment parameters would you monitor closely?

2 An 82-year-old man who is wheelchair dependent and has a history of chronic obstructive pulmonary disease was smoking while using oxygen at home. He sustained superficial partial-thickness burns to his face, including his nose, lips, and chin. This is his second admission for the same type of injury in less than 1 year. His pulse oximetry is 91% and his vital signs are stable. Before he is intubated in the emergency room, he asks for a cigarette and states he wants to go home. What are this patient's immediate care needs? What referrals for inpatient services should be arranged before his discharge? What important factors need to be addressed as part of his discharge plan?

3 A 19-year-old, 233 lb (105 kg) man sustained partial-thickness and full-thickness burn injuries to his face, neck, and both hands and forearms circumferentially that occurred while he was working on his car while smoking a cigarette. Using the rule of nines, estimate the percentage of TBSA burned and estimate his fluid resuscitation needs. What immediate concerns would you have for his airway? How would you handle the care of the circumferential injury of his forearms?

EBP **4** A 52-year-old man suffered an electrical burn when he touched a high-voltage wire inside a closet while on the job. There was an explosion and he was thrown backward. The current entered his right hand and exited his left knee, leaving a large deficit in his knee. He also sustained a 45% TBSA flame burn when his clothing ignited. When asked to rate the intensity of his pain, he reports a "10" on a 10-point pain scale. What immediate concerns would you have related to his cardiopulmonary and neurological status? What strategies would you use to relieve his pain? What is the evidence that supports the pain relief strategies that you identified and the strength of that evidence?

5 A 28-year-old woman involved in a house fire is brought to the emergency department by her boyfriend. There is no information from the scene. She is complaining of severe pain in her neck and back. She sustained a full-thickness burn of her lower extremities and her lower back. She is asking about the status of her two children who perished in the fire. What would you be concerned about related to her complaints that requires action from the burn team? What are the psychological and emotional issues that need to be addressed? Who might you consult to assist in the psychological management of this patient?

The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:

- thePoint online resource, thepoint.lww.com/Smeltzer12E
- Student CD-ROM included with the book
- *Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing*
- *Handbook for Brunner & Suddarth's Textbook of Medical-Surgical Nursing*

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**Asterisk indicates nursing research.*

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RESOURCES

Alisa Ann Ruch Burn Foundation, www.aarbf.org
American Burn Association, www.ameriburn.org
American Red Cross, www.redcross.org
Burn Children Recovery Foundation, www.burnchildrenrecovery.org
Burn Foundation, www.burnfoundation.org/
Burn Institute, www.burninstitute.org
Burn Prevention, www.burnprevention.org
Chemical Educational Foundation, www.chemed.org
Firefighters Pacific Burn Institute, www.ffburn.org
Integra Life Sciences Corporation, www.integra-ls.com
International Association of Fire Fighters Burn Foundation, www.iaff.org
International Medical Education Foundation. www.burnsurgery.org
International Society for Burn Injuries, www.worldburn.org
National Burn Center Reporting System Report Form, U.S. Consumer Product Safety Commission, www.cpsc.gov/burnctr.html
National Fire Protection Association Fire, www.nfpa.org
Phoenix Society for Burn Survivors, Inc., www.phoenix-society.org
United States Fire Administration, www.usfa.dh.gov