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Each year, more than 5000 Americans die as a result of burn-related injuries. Between 1991 and 1993 more than 50,000 people annually were hospitalized in the United States as a result of burn injury, and the number of people burned each year in the United States exceeds one million.[1,2] Fire and burn injuries are the second leading cause of accidental death for children younger than 4 years of age, with scalds being the leading cause of burn injury in this age group. Each year, approximately 112,000 people suffer scald burns, with 6% requiring hospitalization. Not surprisingly, hot tap water accounts for 17% of all childhood scald hospitalizations.[1,2,]

Residential fires account for the overwhelming majority of fire-related deaths, with house fires accounting for approximately 80% of all deaths due to burns.[1,2] However, the number of deaths related to house fires has decreased over the past 20 years, primarily because of the increasing use of home smoke detectors.

Because emergency physicians are responsible for the initial care of most burn patients, a structured and systematic approach is essential for optimizing outcomes in this patient population. With these clinical concerns in mind, this article reviews the emergency management of burns. A number of clinical issues and interventions are emphasized, among them pathophysiology of burns, initial assessment, burn classification, fluid resuscitation, disposition, and follow-up care.

—The Editor

Burn Management: Systematic Patient Evaluation, Fluid Resuscitation, and Wound Management

Author: **David A. Wald, DO,** Assistant Professor of Medicine, Division of Emergency Medicine, Temple University Hospital, Philadelphia, PA.

Peer Reviewers: **Marshall S. Salkin, MD, JD,** Emergency Physician, Northwest Community Hospital, Arlington Heights, IL.

Stephen A. Colucciello, MD, FACEP, Assistant Clinical Professor of Emergency Medicine, University of North Carolina Medical School, Chapel Hill, NC; Director, Clinical Services Trauma Coordinator, Department of Emergency Medicine, Carolinas Medical Center, Charlotte, NC.

The Burn Wound: Clinical Pathophysiology

General Principles. Burns vary significantly in their severity. As might be expected, the degree of thermal injury depends upon both the temperature of the offending agent and the duration of thermal exposure. Generally speaking, exposure to temperatures greater than 45°C leads to cellular damage and protein denaturation. At these temperatures, protein denaturation exceeds the capacity for cellular repair.[3] With exposures longer than one second, hot liquids at temperatures greater than 55° C can produce full-thickness injury. Serious burns produce not only an immediate thermal insult, but also a delayed inflammatory cascade. In the first 8-12 hours, a burn insult is accompanied by impairment of capillary vascular integrity.[4,5] A subsequent increase in vascular permeability occurs secondary to both direct thermal injury and the release of vasoactive substances. This capillary leak produces burn edema as well as "third spacing," a phenomenon characterized by large fluid and protein shifts between the vascular and interstitial spaces.[6] In the absence of aggressive fluid replacement, large burns may lead to hypovolemic shock.

Finally, major burns promote release of inflammatory mediators, including cytokines, prostaglandins, leukotrienes, nitric oxide, and oxygen radicals. Subsequent vasodilatation and inflammatory cell damage can trigger cardiovascular collapse, loss of gastrointestinal mucosal integrity, and multisystem organ failure.[1]

Burn Pathophysiology. Burn wounds consist of three geographic zones. The zone of coagulation occurs at the center of the burn wound, which represents the area of greatest heat transfer. The adjacent area is the zone of stasis, which is characterized by a pronounced inflammatory reaction.[7,8] Local vascular injury limits tissue perfusion to this area, and cell survival is tenuous. With improper wound care or inadequate fluid resuscitation, this area may transform into an area resembling the zone of coagulation. Farthest from the point of direct thermal insult, is the zone of hyperemia, where injury to the tissues is minimal, and spontaneous recovery is the rule.

Initial Assessment

Prehospital Care. Almost without exception, burn management begins at the scene and includes removing the patient from the offending agent. Prehospital personnel should perform a brief primary and secondary survey and initiate stabilization procedures. This may include application of a cervical collar, immobilization of injured extremities, and other maneuvers. If inhalation injury is suspected, prehospital personnel should administer high-flow oxygen and assess the need for endotracheal intubation. In addition, they should remove burned clothing and jewelry

In cases involving chemical burns, medics should be instructed to brush off all dry chemicals and copiously irrigate the skin with water or saline. During transport, large burns should be covered with dry sterile dressings, and small or moderate size burns should be protected with cool, wet dressings. Cool dressings relieve pain and decrease thermal injury if applied during the first 40 minutes after the burn.[9] However, if wet bandages are placed on burns that are greater than 10% of the body surface area, they may produce hypothermia, especially in the very young or old patient.

Large-bore intravenous (IV) access may be started in the moving ambulance in patients with burns involving more than 20% of body surface area. Transport should never be delayed in in the seriously injured patient. Individuals with significant burns require infusion of lactated Ringer's solution or normal saline at a rate of 500 mL/h in adolescents and adults, and 250 mL/h in children between the ages of 5 and 15.[10] To prevent any delay in transport, the advanced burn life-support protocol does not recommend attempting IV access in children who are younger than 5 years old. For children or infants in shock, consider interosseous infusion.

ED Evaluation. Prehospital personnel can provide valuable historical information. In this regard, important aspects of the history include the time, location and circumstances of the injury, where the patient was found, and their condition. Medics should document prehospital care and bystander interventions. Information regarding the patient's past medical and social history, current medication usage, known drug allergies, and tetanus status are also pertinent. If the ED is notified of the arrival of a burn patient, a resuscitation area with airway equipment, dry sterile sheets, and appropriate covering for medical personnel should be prepared. Burn patients should be considered trauma patients, and therefore, they should be systematically evaluated with attention to Airway, Breathing , and Circulation (the ABCs). The airway is the most important initial consideration in the severely burned patient.[3]

Inhalation Injuries. Smoke inhalation accounts for more than 50% of fire-related deaths and is associated with increased mortality.[11,12] Smoke inhalation can obstruct airflow because of mucosal edema, intraluminal debris, inspissated secretions, and bronchospasm.[13] Patients sustaining an inhalation injury may require aggressive airway intervention. Although most injuries result from the inhalation of toxic smoke, on rare occasions, super-heated air will produce direct thermal injury to the upper respiratory tract. Steam carries approximately 4000 times as much heat as dry air.[14]

Place patients who are breathing spontaneously and at risk for inhalation injury on high-flow humidified oxygen.[13] Patients trapped in buildings or those caught in an explosion are at higher risk for inhalation injury. On physical examination, these patients may have facial burns, singeing of the eyebrows and nasal hair, or pharyngeal burns, carbonaceous sputum, or impaired mentation.[15] Any change in voice quality, the presence of stridorous respirations, or wheezing should alert the physician. These findings may be delayed and abrupt deterioration may still occur. In the ED, the upper airway may be visualized by direct or fiberoptic laryngoscopy. Fiberoptic technology is especially valuable for evaluating the tracheobronchial tree. Chest radiography is not

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Managing Editor: David Davenport
Asst. Managing Editor: Catherine Harris
Marketing Manager: Deb Zelnio

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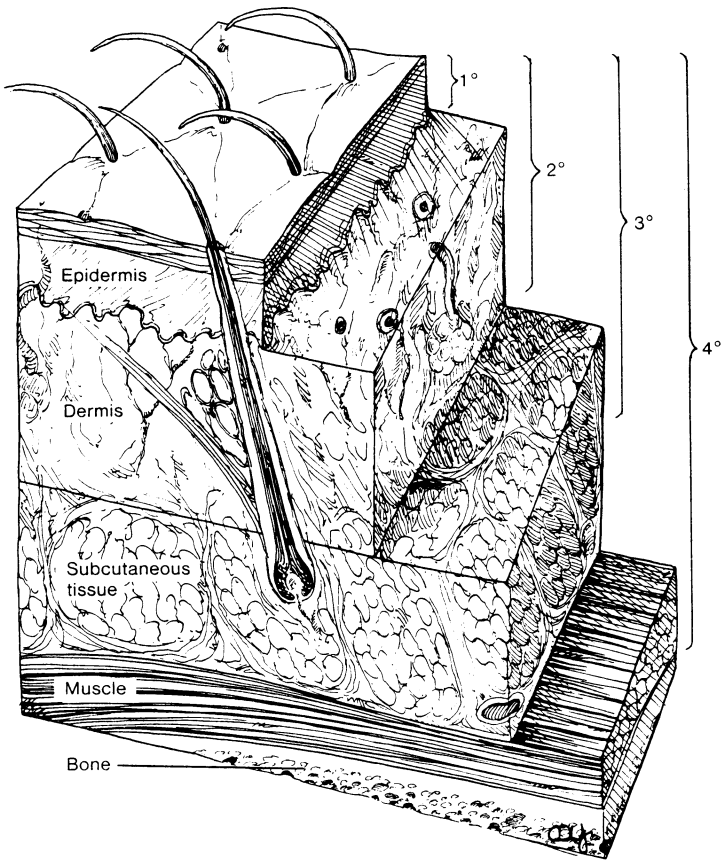
Figure 1. Degree of Burn Wound Depth



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sensitive for detecting inhalation injury and will not predict patients who are likely to decompensate.[12]

Patients who have suffered an inhalation injury are also at risk for carbon monoxide (CO) poisoning. CO has an affinity for hemoglobin 230 times that of oxygen.[16] Carboxyhemoglobin (COHb) decreases the amount of hemoglobin available for oxygen binding, which leads to impaired tissue oxygenation. Because the pulse oximeter measures only oxyhemoglobin and deoxyhemoglobin, it is not accurate in patients with CO poisoning.

In the presence of CO, pulse oximetry usually overestimates hemoglobin oxygen saturation.[17] Standard arterial blood gas (ABG) analysis may also mislead the emergency physician in these cases. The hemoglobin-oxygen saturation obtained from a standard ABG is a calculated value that may be falsely normal. Co-oximetry measurements are necessary to confirm the diagnosis of CO poisoning. Patients exposed to CO should receive 100% oxygen using a nonrebreather face mask. This reduces the elimination half-life of CO from 240 minutes at room air to 60 minutes on oxygen.

Hyperbaric oxygen (HBO) therapy at three atmospheres reduces the half-life of CO to approximately 23 minutes.[5,18,19] Published indications for HBO vary widely, and specific levels of COHb may not correlate with toxicity. Most authorities recommend HBO therapy for patients with CO levels greater than 25%, myocardial ischemia, cardiac dysrhythmias, or neuropsychiatric abnormalities. Because of the potential for producing damage to the developing brain, HBO therapy should be considered for pregnant women and young children with COHb levels of 15% or greater.[14,18-20] Consultation with a poison center may assist management decisions. Cyanide poisoning should also be considered in cases of smoke inhalation.

Burn Classification. After completion of the primary survey, a secondary survey should be performed and should include an assessment of both the depth and total body surface area (TBSA) burned. *(See Figure 1.)* Much of burn wound classification is based upon an accurate assessment of the TBSA affected. Unfortunately, physicians frequently fail to accurately assess burn parameters. Accurate assessment is important because these measurements affect initial fluid therapy, determination of burn severity, and guide management decisions, including the need for transfer to a burn center.[21] First-degree burns involve the epidermis layer of the skin, but not the dermal epidermal layer. These injuries are characterized by pain, erythema, and lack of blisters. Skin peeling may occur as the erythema fades, and these wounds heal without scar formation. First-degree burns are not considered in calculation of the TBSA burned. Second-degree burns are subdivided into superficial and deep partial-thickness burns. Superficial partial-thickness injury involves the papillary dermis. This layer contains the pain-sensitive structures. Blisters or bullae may be present in the ED, or they may develop over several hours. The burns usually appear pink and moist. These injuries heal within 2-3 weeks with little or no scarring.

Deep partial-thickness burn injury damages both the papillary and reticular dermis as well as deeper skin structures such as sweat glands and hair follicles. These injuries may or may not be painful and often appear white or mottled pink. Deep partial-thickness burns are difficult to distinguish from full-thickness injury; they require three or more weeks to heal and can produce significant scarring.

Full-thickness or third-degree burns involve all layers of the epidermis and dermis and may destroy subcutaneous structures. They appear white or charred. Look for thrombosed blood vessels in the wound. These burns are usually insensate due to destruction of nerve endings, but the surrounding areas are extremely painful. Third-degree burns are best treated with skin grafting to limit the functional scarring.

Fourth-degree burns involve structures beneath the subcutaneous fat, including muscle and bone.[9,22]

Table 1. Rule of Nines

Head	9%
Each arm	9%
Anterior torso	18%
Posterior torso	18%
Each leg	18%
Genitals/perineum	1%

Table 2. Burn Classification

MINOR

- Less than 15% TBSA burns in adults or less than 10% TBSA burns in children or the elderly with less than 2% full-thickness injury

MODERATE

- Partial- and full-thickness burns of 15-25% TBSA in young adults, 10-20% in children younger than 10 and adults older than 40
- Full-thickness burns less than 10% TBSA, not involving special care area.

MAJOR

- Greater than 25% TBSA burns in young adults or greater than 20% TBSA in children younger than 10 and adults older than 40.
- Full-thickness burns of 10% or greater. All burns of special care areas that are likely to result in either functional or cosmetic impairment (i.e., face, hands, ears, or perineum).
- All burns complicated by inhalation injury, high-voltage electrical injury, or associated major trauma. High-risk patients include infants, the elderly, and patients with complicated medical problems.

Adapted from: American Burn Association 1984 Guidelines for Service Standards and Severity Classifications in the Treatment of Burn Injury.

The estimation of TBSA burn is frequently based upon the "rule of nines." *(See Table 1.)* This estimate may be adequate for adults, but often underestimates burn size in infants and children who have much larger surface body area to weight ratios. The size of small burns has previously been estimated using the "rule of palms." This measurement was based upon the assumption that a burn the size of the patient's palm accounts for roughly1% of the TBSA. However, a recent study suggests that the entire palmar surface of a child's hand more closely approximates 1% TBSA than the palm itself. A more accurate determination of the TBSA burned can be made using a variation of the Lund and Browder burn size chart. This chart takes into account the different proportions of the body at various ages. *(See Figure 2.)* In addition to the depth and the TBSA affected, burn severity is linked to burn location, patient age, associated trauma, and the presence of comorbid disease. *(See Table 2.)*

Management Principles: Moderate to Severe Burns

Initial Interventions. As a rule, initial wound care in the ED should be delayed until completion of the primary and secondary survey. Immediate life threats should be addressed, and initiation of fluid resuscitation should precede initial wound care.

Administer tetanus prophylaxis as indicated. Routine use of antibiotics is not generally recommended for initial management of burns but may be considered in the young child with a known or suspected streptococcal infection.[23] In patients who require transfer to a burn center, keep all burn wounds covered with sterile dressings and allow the specialty care hospital to debride the wound and apply topical antimicrobials as required. Prior administration of topical antimicrobial agents may impair initial wound evaluation at the burn center.

Insert a nasogastric (NG) tube in patients with burns involving 20% or more TBSA in order to prevent gastric distention and emesis associated with a paralytic ileus.[24-26] In all patients requiring hospitalization, obtain routine laboratory studies including a complete blood count, electrolytes, serum glucose, BUN, and creatinine. Additional laboratory studies may include an ABG, COHb level, urinalysis, urine myoglobin, coagulation studies, blood type and screen, toxicology screen, serum ethanol level, and serum protein.[23,25,26] Patients with known heart disease or patients at risk for cardiac complications require a baseline ECG. In addition to an admission chest x-ray, obtain other radiographs as clinically indicated.

Definitive Treatment Measures. After completion of the primary and secondary survey, priority should be given to pain management. Partial-thickness burns are intensely painful and patients may require IV narcotics. Because intramuscular narcotics may have erratic and unpredictable absorption in patients with capillary leak syndrome, repeated boluses of IV narcotics are safer and more effective. If the wound requires debridement, the patient must be given adequate analgesia and sedation.

Complications associated with eschar formation may occur in any patient with circumferential, deep partial- or full-thickness burns. Emergent escharotomy can relieve life- or limb-threatening constrictions caused by circumferential burns. When these burns involve the chest, they can cause ventilatory restriction; neck burns also can lead to airway compromise. Circumferential extremity burns may impair distal circulation.

When life or limb is threatened, the physician should incise the eschar through the dermis into the level of the subcutaneous fat. The wound should open significantly and bleed if the incision is made to the proper depth. If a chest escharotomy is required, cut the skin from the clavicles to the costal margin along the anterior axillary line. This incision may be joined by a transverse incision along the superior, anterior abdominal wall. If a neck escharotomy is required, place the incisions posterio-laterally to avoid vascular structures. On the extremities, incisions are made on the medial and lateral surfaces, paying careful attention when crossing the joints so as not to injure neuro-vascular structures.

Initial Fluid Resuscitation. Adequate volume replacement decreases the morbidity and mortality associated with severe burn injury. The goal of initial fluid resuscitation is to restore and maintain vital organ perfusion. In adults, IV fluid resuscitation is usually necessary in second- or third-degree burns involving greater than 20% TBSA.[5,25] In pediatric patients, fluid resuscitation should be initiated in all infants with burns of 10% or greater TBSA and

Figure 2. Chart for Estimating Body Surface Area Burn

Area	Birth 1 yr.	1-4 yr.	5-9 yr.	10-14 yr.	15 yr.	Adult	2°	3°	Total	Donor Areas
Head	19	17	13	11	9	7				
Neck	2	2	2	2	2	2				
Ant. Trunk	13	13	13	13	13	13				
Post. Trunk	13	13	13	13	13	13				
R. Buttock	2½	2½	2½	2½	2½	2½				
L. Buttock	2½	2½	2½	2½	2½	2½				
Genitalia	1	1	1	1	1	1				
R. U. Arm	4	4	4	4	4	4				
L. U. Arm	4	4	4	4	4	4				
R. L. Arm	3	3	3	3	3	3				
L. L. Arm	3	3	3	3	3	3				
R. Hand	2½	2½	2½	2½	2½	2½				
L. Hand	2½	2½	2½	2½	2½	2½				
R. Thigh	5½	6½	8	8½	9	9½				
L. Thigh	5½	6½	8	8½	9	9½				
R. Leg	5	5	5½	6	6½	7				
L. Leg	5	5	5½	6	6½	7				
R. Foot	3½	3½	3½	3½	3½	3½				
L. Foot	3½	3½	3½	3½	3½	3½				
						TOTAL				

Cause of Burn _____

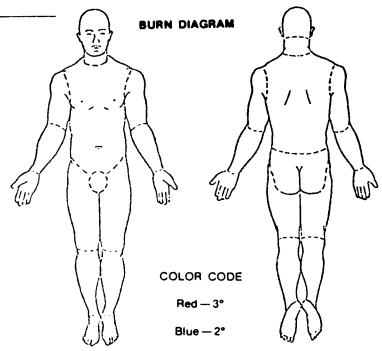
Date of Burn _____

Time of Burn _____

Age _____

Sex _____

Weight _____



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in older children with burns greater than 15% or greater TBSA.[27]

Most, if not all, patients who require fluid resuscitation will need two large-bore IV lines. It may be helpful to obtain central venous access at the time of initial treatment before landmarks are lost secondary to progressive burn edema. The clinical response of the patient should guide fluid resuscitation.

Any formula used to estimate fluid requirements should only be used as a guideline. In this regard, urine output is a measure of renal perfusion and can help assess fluid balance. In adults, a urine output of 0.5-1.0 mL/kg/h should be maintained. Urine output may be affected by the use of diuretics or by the presence of glycosuria, which can cause an osmotic diuresis. Greater urine output may be needed in the presence of rhabdomyolysis, to prevent pigment nephropathy and acute tubular necrosis.

Patients with significant burns should have a Foley catheter inserted in order to monitor urine output. Lactated Ringer's solution is the most commonly used fluid for burn resuscitation in the United States.[4,26,28] Various formulas for initial fluid replacement, include the Evans, Brooke, Modified Brooke, and the Parkland formula. The Parkland formula is most commonly used to guide initial fluid resuscitation during the first 24 hours.[1] The formula calls for 4 cc/kg/TBSA burn (second and third degree) of lactated Ringer's solution over the first 24 hours.[28] The fluid should be administered as follows: half over the first eight hours post burn, and half over the next 16 hours. Half of the resuscitative volume is given in the first eight hours post burn to adjust for edema formation and plasma fluid loss.[4-6] The volume of fluid given to a burn patient is based on the time elapsed since the burn. For example, if a patient was burned several hours prior to receiving intravenous fluids, add the volume the patient should have received during that time to the total fluid calculations, (i.e., the physician will need to "catch up" with the fluid deficit.)

In addition to lactated Ringer's solution, other fluid regimens have been proposed for resuscitation of the burned patient. Hypertonic saline solutions and colloid containing solutions have been studied as an alternative to isotonic crystalloid. Hypertonic saline has a greater osmotic pressure as compared to the more commonly used crystalloids. Hypertonic saline has been evaluated to determine whether it reduces fluid requirements needed for the acute resuscitation, and therefore, whether it limits burn edema.[6,29] Although fluid requirements have been decreased, studies have shown mixed results,. Benefits have yet to be clearly realized, and the optimal amount of these solutions required is unclear.[6,29,30]

Because colloid-containing solutions have an increased oncotic force compared to crystalloids, it was presumed that they might cause less edema and third-spacing during the first eight hours post burn.

However, because there is an initial protein leak, colloid-containing solutions are no more effective than crystalloids, and they are considerably more expensive.[5,10,31] Colloid-containing solutions are not commonly used during the acute phase of fluid resuscitation. Some studies have shown volume sparring effects, but it is unclear as to the optimal amount of protein to be infused.[6,32]

In most circumstances, lactated Ringer's solution is recommended as the initial fluid in resuscitating the burn patient.

It should be emphasized that increased fluid requirements may be needed in patients with inhalation injury, electrical injury, other associated trauma, or a delay in fluid resuscitation.[8,33]

Pediatric Burn Patients. In children, fluid resuscitation is of special importance, since children have an increased body surface area-to-weight ratio and have greater fluid requirements than those determined using standard weight based formulas. Young children require more fluid per kilogram for burn shock resuscitation than adults with similar thermal injury.[34,35] It is always imperative to distinguish between accidental burns and patterns suggesting child abuse (immersion vs scald).

In children, maintain adequate tissue perfusion, which is best judged by maintaining a urine output of about 1 cc/kg/h.[5,27] In young children, it is imperative not to forget about maintenance fluid requirements.[34,35] *(See Table 3.)* Failure to include maintenance fluids when resuscitating a young child with a moderate or major burn can result in significant "under-resuscitation" and vital organ hypoperfusion.

The New York Hospital-Cornell Medical Center Burn Center recommends using maintenance fluids plus the Parkland calculation for pediatric fluid resuscitation. Other authorities recommend using standardized body surface area nomograms and basing fluid resuscitation on the formula of 5000 mL/m^2 burned area and 200 mL/m^2 TBSA for maintenance fluids.

Maintenance fluids may be administered as 5% dextrose in one-half normal saline.[7] Daily maintenance fluids are based upon

Table 3. Fluid Requirements in the First 24 Hours (Example)

70 KG ADULT WITH 50% TBSA BURN (PARKLAND FORMULA)

4 cc/kg/TBSA = 4(70)(50) = 14,000 cc of lactated Ringer's in first 24 hours: 7000 cc in first eight hours post burn, then 7000 cc over the next 16 hours.

15 KG CHILD WITH 50% TBSA BURN (MAINTENANCE PLUS PARKLAND)

Maintenance fluids = 100(10) + 50(5) = 1250 cc of D5 1/2 NS over 24 hours. 4 cc/kg/TBSA = (4)(15)(50) = 3000 cc of lactated Ringer's in first 24 hours: 1500 in the first eight hours post burn, then 1500 cc over the next 16 hours.

the child's weight; 100 cc/kg for the first 10 kg, then 50 cc/kg up to 20 kg, then 20 cc/kg for anything above 20 kg. It is important to monitor blood glucose levels in pediatric patients because of the limited glycogen stores and susceptibility to hypoglycemia. In addition to urine output, adequacy of fluid resuscitation may be observed by monitoring mental status, pulse, pulse pressure, capillary refill, and blood gases to determine the presence of acidosis.[27]

Disposition. The overwhelming majority of burn patients seen in the ED require only outpatient care. However, approximately 5% of burn patients will need hospitalization. and some will benefit from transfer to a burn center.

If the ED physician anticipates the need for transfer to a burn center, early contact with the referral center should occur. Applicable federal guidelines (EMTALA) should be followed. Most moderate burns and all major burns require hospitalization. The American Burn Association has established criteria for burn center referral. *(See card inserted in this issue.)*

Outpatient Management: Minor Burns

Outpatient care for minor burns requires that the patient have access to the health care system and is able to comply with instructions. Other considerations include status of the family support system and the patient's general state of health.

Patient Selection. Successful outpatient management requires proper patient selection. In this regard, it should be stressed that burns involving "critical" areas of the body such as the hand or foot may represent only 2-3% TBSA, but have the potential for serious functional impairment. Alternatively, it may be appropriate on occasion to admit minor injuries in order to facilitate proper wound care in the unreliable or debilitated patient.

When initiating outpatient care, the physician should provide a specific plan for follow-up before discharge from the ED. In addition to home wound care, most patients should be instructed about performing active range-of-motion exercises. Some patients require outpatient physical therapy, hydrotherapy, and an extensive exercise program. If follow-up care is to be provided by a plastic surgeon or a burn specialist, discuss the case with your colleagues prior to discharge. Document the diagnosis, the treatment provided, and recommended follow up.[36] A prescription for pain medication is essential for all but minor burns.

Wound Care Principles. Providing outpatient care for the burn patient is well within the realm of emergency medicine, but many controversies still exist regarding optimal care of minor burns. Minor burn injuries are not associated with immunosuppression, hypermetabolism, or an increased susceptibility to infection. Nevertheless, a number of misconceptions regarding the care of the minor burn wounds have occurred as a result of extrapolating issues associated with major burns to minor burns.[37]

In general, the same wound care principles that apply to other minor wounds can be applied to minor burns. NSAIDs have become the standard of care for minor burns in many EDs. As mentioned earlier, tetanus status needs to be addressed. The burn wound should be cleansed with a mild soap and water or saline; hair in or around the burn should not be shaved.[3,24,9] Devitalized tissue or ruptured blisters should be debrided using aseptic technique. For management of hot tar burns, cool the area and use emollient or ointment, but do not peel tar off.

Blisters. There is some controversy regarding the optimal management of intact blisters. Clinical approaches to intact blisters include leaving them intact, aspiration, and deroofing or debriding.[37] In general, blisters should be left intact in order to decrease the likelihood of bacterial colonization, but there are strident differences of opinion on this point.[9,38] Large or tense blisters may be decompressed by needle aspiration; this approach may be preferable if proper wound care would otherwise be difficult due to the size of the blister.[9] Minor burn wounds can also be subject to burn wound edema. This is especially true in dependent areas such as the lower extremities. In these cases, it may be necessary to elevate and immobilize dependent areas in order to facilitate proper healing.

Dressings. Some minor burns can be managed in an open fashion,without occlusive dressings. Burns to the neck and face are most often treated in this manner. These wounds should be washed twice daily with soap and water followed by application of a topical antibiotic such as neosporin or bacitracin. It is also important to instruct patients to avoid sun exposure during wound maturation, as the exposure may lead to permanent hyperpigmentation.[37]

Most outpatient burns are managed with closed dressings[9,23] that can be applied with or without the addition of topical antibiotics. The initial layer of this dressing is usually a nonadherent porous, dry, sterile gauze that is then covered with a layer of bulky gauze to absorb wound exudate. The dressing is then covered with a semielastic wrap.

The most commonly used antimicrobial agent is 1% silver sulfadiazine (silvadene); this odorless, water-soluble cream should be avoided in patients with allergies to sulfonamides, pregnant women approaching or at term, or on newborn infants during the first two months of life. A thin layer of cream can be applied to a sterile gauze using a tongue blade, and then the gauze is applied to the burn.

Generally, these dressings are changed daily or twice daily and can be removed at home in the shower or under running water. The burn is then gently washed with a mild soap and water, the old cream is removed, the wound patted dry and redressed as above. If closed dressings are used without topical antimicrobial agents, the dressings can be changed on a daily or every other day basis. All burns treated as an outpatient should be reevaluated in 24-48 hours and then, depending upon the specific injury, may need daily follow-up or should be examined every 3-5 days until healed.

Topical Antibiotics. The use of topical antibiotics still remains an area of continued debate in the context of outpatient burn care. These medications were initially used to help decrease wound infection and sepsis associated with invasive burns. His-

torically, these agents have been used prophylactically for serious burns, and since their routine use, there has been approximately a 50% decrease in mortality associated with burn injury.[39] In addition to silvadene, other agents that may be used include mafenide acetate (sulfamylon) and silver nitrate.

Use of any of these agents may lead to wound maceration, and because there is a loss of potency over 6-24 hours, frequent dressing changes are required.[23] Although these preparations are widely used, some authors do not recommend their use for the outpatient care of minor burns. In fact, it is not clear that these medications offer any benefit in the treatment of first-degree or partial-thickness injury.[9,26,37] Complications of silvadine therapy include leukopenia and staining of sun-exposed skin.

Accordingly, most experts consider the use of topical antimicrobial agents important for the treatment of larger, deep partial- or full-thickness burns that are managed as an outpatient.[23,26] The proper use of topical agents may lead to spontaneous healing of burn wounds that initially appeared to be full-thickness injury.[39] Once again, it should be emphasized that superficial, partial-thickness burns usually heal within 2-3 weeks with conservative treatment. Aloe vera may be used with good results in these cases. In patients with deeper wounds, early aggressive wound excision and grafting has largely replaced conservative care.[8]

A third option for managing outpatient burns is the use of synthetic dressings such as Tegaderm, DuoDerm, Biobrane, and Op-Site. These types of dressings have been useful for treating partial-thickness burns and should not be used on deep partial-thickness or full-thickness injury.[26] Deep partial- and full-thickness burns most often require aggressive wound care and early excision and grafting. If these deeper burns are initially treated on an outpatient basis, it is more prudent to use an antimicrobial agent and a closed dressing.

The occlusive dressings may promote healing, decrease pain, require less frequent dressing changes, and decrease treatment costs as compared to topical antimicrobials.[40,41] Synthetic dressings should not be used on infected burns and only on fresh burns after initial wound care. All blisters and devitalized tissue need to be debrided.[9,40] The synthetic dressing should then be applied with minimal tension and should extend 1-2 cm beyond the burn margin. After application, the site should be covered with gauze and a semielastic wrap, and the covering should be changed daily.

The wound should be inspected on a daily or every other day basis. If a small amount of fluid accumulates under the adhesive dressing it may be necessary to needle aspirate the fluid. If fluid continues to accumulate during follow up visits, or if the dressing becomes nonadherent it may be necessary to remove the occlusive dressing and use conventional dressings. The synthetic dressing may stay in place until epithelialization occurs.

Summary

Burn injury remains an important cause of morbidity and mortality among patients seen in the ED. A systematic approach to burn management, with vigilant attention to fluid resuscitation and wound care will maximize outcomes and reduce complications. Prevention-oriented education should including counsel regarding water temperature in hot water heaters and cigarette use.

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CME Questions

33. The initial management of a critically burned patient would include:
    A. aggressive fluid resuscitation.
    B. emergent escharotomy if circumferential burns are present.
    C. Immediate airway management.
    D. Burn wound debridement.

34. Superficial partial thickness burns involve which layers of the skin?
    A. The epidermis, dermis, and may involve subcutaneous tissues
    B. Only limited to the epidermis
    C. Involves the epidermis, and the papillary and reticular dermis
    D. involves the epidermis, and the papillary dermis

35. Which of the following may increase fluid resuscitation requirements?
    A. Electrical injury
    B. Inhalation injury
    C. Associated pelvic fracture
    D. A three-hour delay in initiating fluid resuscitation
    E. All of the above

36. During pediatric fluid resuscitation, what is the recommended maintenance fluid to be administered?
    A. Normal saline
    B. Lactated Ringer's solution
    C. 5% dextrose in normal saline
    D. 5% dextrose in one-half normal saline

37. What is the most common fluid used in burn resuscitation in the first 24 hours?
    A. Hypertonic saline
    B. Hypotonic saline
    C. Colloid-containing fluid
    D. Lactated Ringer's solution

38. Findings suggestive of an inhalation injury may include?
    A. Wheezing
    B. Facial burns
    C. Carbonaceous sputum
    D. Pharyngeal erythema
    E. All of the above

39. Which of the following would be considered a moderate burn, according to the American Burn Association?
    A. Full-thickness burn of 15%, not involving special care areas
    B. Partial-thickness burn of 25% in a child
    C. Partial-thickness burn of 20% in an adult
    D. Partial-thickness burn of 10% in an adult with an associated pelvic fracture

40. If an emergent escharotomy needs to be performed to relieve circulatory embarrassment caused by a circumferential burn, the incision is made:
    A. through the epidermis into the dermis.
    B. through the epidermis, dermis, and into the level of the subcutaneous fat.
    C. through the subcutaneous fat into the underlying fascia.
    D. through the underlying fascia into the muscular compartments.

Correction

Please note that in the January 19, 1998 issue, incorrect dosages for lorazepam and vecuronium were listed in two tables. In Table 3 under the midazolam protocol, the dosage for lorazepam should read 0.02-0.05 mg/kg IV. In Table 7, the adult dose for vecuronium should be 0.1-0.3 mg/kg. A rapid access card containing corrected tables will appear with a future issue of *Emergency Medicine Reports.*

In Future Issues

Acute MI