Initial Management of the Burned Patient

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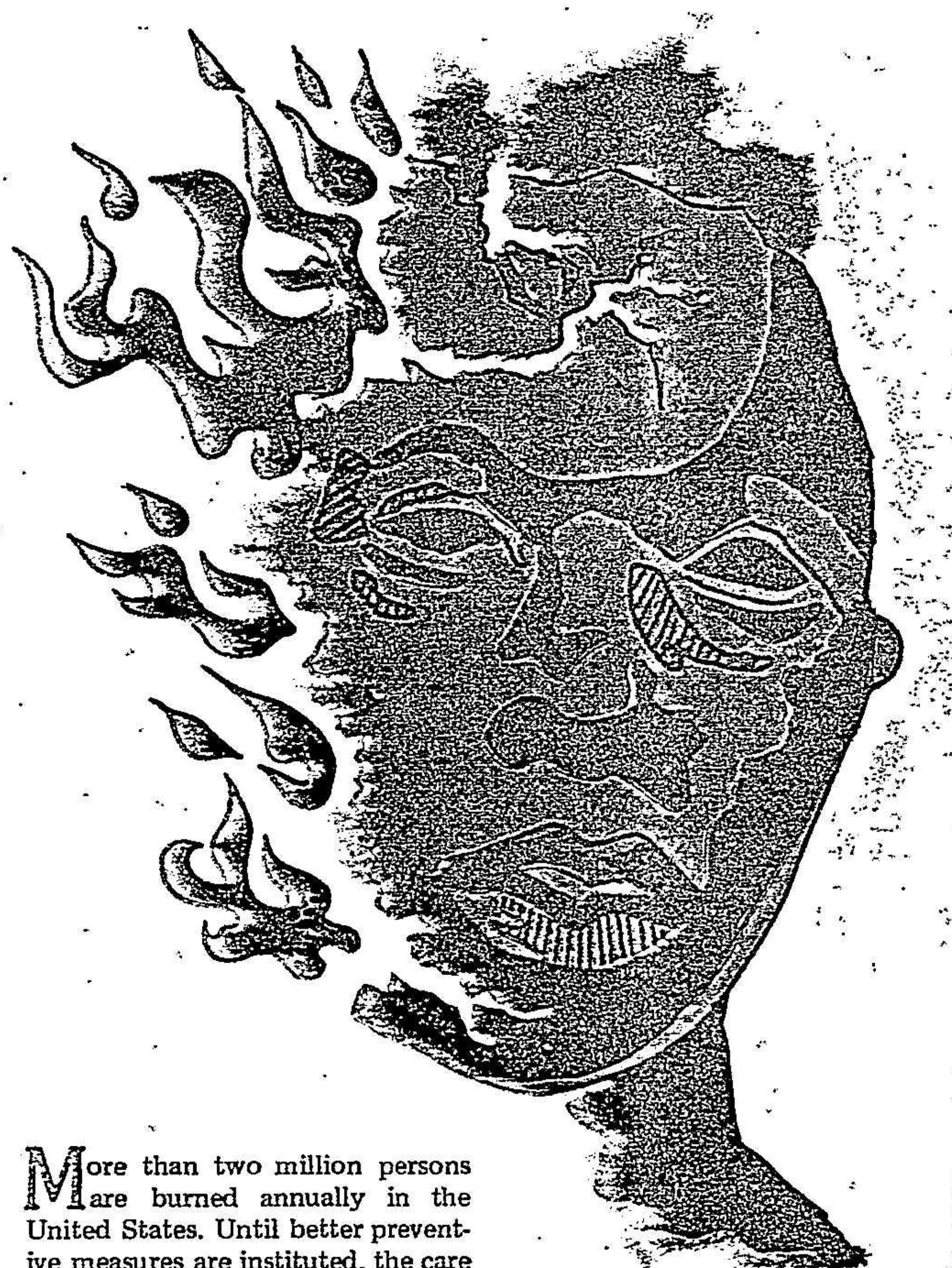

More than two million persons are burned annually in the United States. Until better preventive measures are instituted, the care of the burned patient, both immediate and late, will continue to be a health problem of serious proportions.

Proper immediate care necessitates an appreciation of the many potential problems—apart from the obvious burns—that may confront these patients. Prompt and comprehensive treatment of the extensively burned patient by the initial emergency team is required, not only for successful resuscitation in the receiving hospital or burn center but also for avoidance of serious complications and late fatalities in those who survive the early shock phase. The role played by those who are responsible for the burned patient's initial care cannot be overestimated.

Incomplete or inaccurate information about the injury or past medical history, inaccurate assessment of the depth and extent of burns, and failure to recognize associated, potentially serious, nonthermal injuries are common errors in the initial assessment. These often result in an excessive or inadequate rate of intravenous fluid therapy or omission of a required treatment that is essential for survival.

An accurate and detailed history of the thermal injury is needed to predict depth of the burns and likelihood of other associated injuries. In descending order of burn depth are pure electrical burns, flame burns with ignition of clothes, flash burns, immersion and scald injuries. Associated injuries often exist, especially when the burns result from an explosion or a highway accident. Pelvic fractures with concealed retroperitoneal hemorrhage, subdural hematoma, and pneumothorax may coexist with extensive cutaneous burns; if ignored, they can result in unexpected early or late fatality. Respiratory insufficiency with hypoxemia and circulatory collapse with lactic acidosis due to rapidly developing hypovolemia are common, immediate threats to survival.

Severe inhalation injury due to exposure of the respiratory epithelium to toxic gases is normally seen when the victim was exposed to flames and smoke in a closed space; however, mild inhalation injuries can occur in open spaces as well.

Burns around the nares and mouth, singed nasal hair, carbon in the oropharynx or carbonaceous

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expectoration, hoarseness, cough, cyanosis, rales or wheezes and mild to moderate hypoxemia are all important findings in inhalation injury. The noxious gases of combustion can cause severe hypoxia and immediate death as a result of carbon monoxide poisoning or can chemically injure the larynx and trachea and/or the pulmonary parenchyma. Usually, radiographs of the chest are initially normal. Perfusion-ventilation xenon lung scans show the expected defects. Early fiberoptic bronchoscopy is the most reliable means to establish the diagnosis of inhalation injury, but it is best deferred until the patient reaches the definitive care facility.

Electrical injuries deserve special attention because potentially they may cause serious sepsis and loss of limb as a result of injury to the muscles and vasculature, death due to cardiac arrhythmia, or apnea from injury to the respiratory center in the brain stem. Unfortunately, these serious or fatal complications can occur in patients who may have small or negligible cutaneous burns and thus be considered trivial.

Management of the Respiratory System

Significant respiratory insufficiency is not an expected finding within a few hours after burn injury. On the contrary, most patients initially develop respiratory alkalosis as they hyperventilate due to the acute emotional disturbance and pain. However, fatalities can occur as a result of severe hypoxia due to carbon monoxide poisoning, upper airway obstruction, and laryngeal edema in inhalation injury.

Associated thoracic trauma, e.g. pneumothorax, and pre-existing chronic obstructive pulmonary disease are serious causes of early respiratory insufficiency. Appropriate therapy is necessary prior to transfer.

The burned patient is potentially at risk at all levels of the respiratory apparatus. Recognition of existing problems and prevention of potential ones is vital for survival.

Respiratory center depression can occur from overzealous narcotic or barbiturate administration or overdose in suicidal cases. A drug screening blood sample should be obtained in such instances. Barbiturates should be avoided as they can cause severe agitation. Narcotics should be given only intravenously and in small doses to titrate accurately the minimum doses required for analgesia and sedation.

Transnasal oxygen enrichment of the inspired air is needed for all patients with greater than 30% B.S.A. burns. Oxygen should be given to elderly patients even if the wounds are minor. Four liters of oxygen flow per minute is all that is needed for most burned patients prior to and during transfer.

Dyspnea and tachypnea may occur due to subdermal circumferential, constricting burns of the thorax or abdomen that can seriously impede and diminish inspiratory expansion of the thorax or diaphragm. Cruciate escharotomies from lower neck to the xiphoid process and circumferentially in transverse direction along the thorax usually relieve the dyspnea and tachypnea by increasing the tidal volume and reducing the respiratory work load.

Upper airway obstruction due to massive edema, especially when the larynx is involved, may necessitate immediate endotracheal intubation. The nasotracheal route is preferred. Immediate tracheostomy is usually unnecessary and may result in subsequent increased morbidity and pulmonary infection, especially if the tracheostomy is performed through burned skin.

Ileus of varying degree regularly accompanies thermal injury. Nasogastric tube decompression and emptying of the stomach prevent further ventilatory insufficiency, due to elevation of the diaphragm, and also protect the patient from a potentially fatal aspiration pneumonia.

Endotracheal intubation and thoracic escharotomy to improve ventilation in general will rarely be needed and should be considered only in extensive injuries and especially when transportation time is greater than one to two hours.

Management of the Circulatory System

It is mandatory to promptly infuse an effective saline solution intravenously at an adequate rate, as the magnitude and rate of plasma loss is great (proportional to the burn extent) and poses an immediate threat to survival.

Venous cannulation should be performed preferably through unburned skin by venous cutdown only, as percutaneous venous short catheters or needles usually result in loss of intravenous line as edema increases and during moments of agitation.

Thermal injury results in depletion of all blood constituents; however, rate and magnitude of loss of each blood component is different. Red cells are initially destroyed due to the transmitted heat and, subsequently, as a result of hemolysis due to spherocytotic transformation of the injured erythrocytes. Within the first 24 hours the circulating red cell mass may be reduced by one-third in patients with 50% or larger B.S.A. flame burns. Fifty percent of the intravascular protein mass can be lost from the circulation during the first five hours or so. Salt and water losses are by far the most rapid and significant in magnitude. The plasma volume can be reduced *by half in the first two hours postburn* or one-fifth of the original after five hours in spite of mild to moderate red cell mass destruction; proportionately, much more plasma sodium and water is lost. The net effect is hemoconcentration that usually returns toward normal, even with aggressive fluid therapy, only after 48 hours or more.

Blood need and should not be administered initially to most burned patients, as it can cause further increase in blood viscosity and impede capillary circulation. But blood may be necessary if there has been significant hemorrhage from associated injuries.

The pathophysiologic effects of a major burn are blood volume reduction, increased blood viscosity, decreased cardiac output, decreased glomerular filtration rate and consequent oliguria. The basic cause for the hypovolemia is a heat-induced capillary hyper permeability which results in massive extravasation of water, salts, proteins, and even erythrocytes into the burn wound. This abnormal hyper permeability of the capillaries usually persists for 36-48 hours. Some still recommend the administration of large quantities (from 0.5 to 1.0 ml/kg/% BSA burn) of plasma or albumin in an attempt to restore plasma volume by increasing the plasma oncotic pressure. We disagree. It is clear that plasma administration in the treatment of post-

Initial Assessment and Management of Burned Patients

A. Obtain accurate history.
- 1. Scalds — Generally superficial, unless immersion injury.
- 2. Flame burns — Deep usually. Smoke inhalation?
- 3. Electrical injury:
  - a) Loss of consciousness?
  - b) Apnea?
  - c) Arrhythmia?
  - d) Cardiopulmonary resuscitation at scene of accident?
  - e) Injury much more serious than external appearance of wounds.

B. Complete physical exam
- 1. Level of consciousness.
- 2. Vital signs:
  - a) Blood pressure;
  - b) Pulse, especially distal to constricting eschars — use Doppler PRN;
  - c) Respiratory rate and depth;
  - d) Work and effort of breathing — constricting thoracic circumferential eschars?
  - e) Evidence of inhalation injury — burns around mouth and nostrils, singed hair, carbon in oropharynx and sputum, wheezes in chest, hoarse voice.
- 3. Estimate depth and size of wounds using "rule of nines." Note gross contamination.

C. Initial management
- 1. Respiratory support:
  - a) Nasal oxygen 4 liters/min for major burns and especially in elderly patients;
  - b) Endotracheal intubation in most severe burns with altered consciousness or respiratory insufficiency — needed infrequently;
  - c) Avoid tracheostomy;
  - d) Nasogastric intubation and emptying of stomach in major burns;
  - e) Escharotomies of subdermal constricting thoracic eschars.
- 2. Cardiovascular support:
  - a) Venous cutdown, for greater than 20% B.S.A. burns;
  - b) No scalp vein needles or percutaneous short venous catheters;
  - c) Use plain Ringer's lactate or normal saline if former not available — to ensure 30-40 cc urine per hour;
  - d) Insert Foley catheter;
  - e) Do not infuse glucose;
  - f) Do not transfuse blood, unless associated trauma with significant hemorrhage;
  - g) No digitalis;
  - h) No diuretics.
- 3. Sedation:
  - a) I.V. route only;
  - b) Demerol or morphine in repeated small doses;
  - c) No barbiturates;
- 4. Wounds:
  - a) Cleanse gross contaminants gently;
  - b) Apply a bulky occlusive dry dressing;
  - c) Escharotomies in circumferential subdermal burns — particularly if transfer time is more than one or two hours.
- 5. Consult burn center physicians:
  - a) For pre-transfer and en route comprehensive therapy;
  - b) In general, patients with greater than 30% B.S.A. burns should be transferred to a burn center.

burn hypovolemia is expensive and unnecessary. The worldwide trend is away from the use of colloid. On theoretical grounds, the exogenous plasma proteins would be expected to share the same fate as endogenous proteins: accumulation in the wound where they increase tissue oncotic pressure and so tend to exaggerate and prolong edema. More important, no one has proved that the use of colloid increases either quality or rate of survival.

Salt water therapy replenishes the predominant losses, is readily available, and is inexpensive. Sodium, the principle osmotically active cation of the extracellular space, plays the major role in maintenance and restoration of extracellular space and plasma volume. Most experts now use sodium solutions exclusively during the initial treatment of major burns. Ringer's lactate (a hypotonic sodium solution—130 mEg sodium/liter) is usually administered at 4 cc/kg/% burn in the first 24 hours, but its use often results in unnecessarily massive edema of both burned and unburned parts. We have successfully used a hypertonic lactated saline solution (sodium 250 mEq/liter, lactate 100 mEq/liter, chloride 150 mEq/liter) with smaller gains in body weight and less edema. The solution is infused at a rate to ensure an hourly urine output of about 30-40 cc only. This hypertonic saline, containing almost twice as much sodium as Ringer's lactate, has proved to be equally as effective; usually half as much fluid is used compared to the volume required when lactated Ringer's is employed. Such therapy thus minimizes the risks of cardiopulmonary overload and pulmonary edema and also prevents excessive wound edema and its deleterious consequences of delayed healing. The exogenous lactate anion acts as a bicarbonate precursor and generally maintains a normal pH by neutralizing the dilutional acidosis trend of the excess chloride (150 mEq chloride/liter vs serum chloride of 100 mEq/liter). Plain Ringer's lactate is available in all emergency units and should be the first intravenous fluid for patients with burns exceeding 15% B.S.A. It should be administered at a rate to maintain a urine flow of 30 cc/hr in adults. Glucose should not be initially administered as stress hyperglycemia is usually present and exogenous glucose may further increase the serum osmolarity and precipitate hyperosmolar nonketotic coma. Patients with delayed or inadequate initial intravenous fluid therapy often require larger fluid loads or fail to respond to treatment.

Management of the Wound

The first principle in wound management should be *avoid further damage or contamination.* Cold water towels, if applied immediately after the burns, not only soothe the pain but may also diminish the penetration of thermal injury. Dry, clean, bulky bandages or sheets should be applied next to prevent contamination. Immersion in non-sterile water can seriously and heavily contaminate the eschars that would obviously result in wound sepsis. Washing or scrubbing with soap or "antiseptic" solutions should be avoided because of potential further chemical or mechanical trauma. Gross and obvious debris should be removed gently and the extent and depth of the burns determined. In circumferential subdermal burns, if the eschars are tight, leathery, and potentially constrictive, one should check status of the circulation distally, carefully noting speed of capillary filling, presence or absence of distal pulses, and whether sensory or motor nerve deficit exists. Doppler ultrasound may be used to check the presence of weak pulses and read inaudible blood pressures. Circumferential burns of the leg can result in foot drop due to compression of the neurovascular bundle from increasing edema in the anterior compartment, those of the upper limb in loss of digits or hand. Such complications can be prevented by generous escharotomy performed prior to transfer. If proper indication for escharotomy exists, one should achieve about two finger breadth separation of the cut eschar edges. It is important to carry the escharotomy all the way to the muscle fascia to ensure adequate release. One common error of escharotomy or fasciotomy is not extending the incision far enough proximally and distally.

In electrical injuries, compression is caused mainly by the deep fascia that surrounds the compartment musculature, therefore fasciotomy is often required in addition to escharotomy to achieve adequate decompression of the electrically injured and edematous muscles.

When to Hospitalize

Hospitalization is generally recommended for 2° burns of greater than 10%-15% B.S.A. in extent. Smaller 2° burns in the elderly and in children less than five years old are preferably hospitalized due to increased morbidity in these age groups. Smaller wounds of the face, perineum, hands, and feet are also best managed on an in-patient basis. All electrical and inhalation injuries should be hospitalized because of potential serious complications. Third degree burns, even of small extent, should be hospitalized. Prompt excision and grafting allow healing in the shortest possible time and minimize and avoid the morbidities of prolonged burn wound care, e.g. sepsis, pulmonary embolism.

When to Transfer to a Burn Center

In general, patients with greater than 30% B.S.A. burns should be transferred to a burn center. True electrical injuries that often threaten the viability of limbs and result in serious sepsis and organ failure are best managed in burn centers. Patients with significant inhalation injury also require intensive care and should be treated in a burn center.

Finally, physician to physician consultation is strongly recommended to ensure proper initial care and correct and safe transfer of the burned patient.

Case History

A two-year-old boy was severely burned when a gasoline can exploded in his home's basement. Extrication from the flames, which ignited his clothing, was difficult because of smoke, with the result that his clothing burned off. His burns were correspondingly deep. The patient was taken to a local hospital within 15 minutes, where he received Demerol 20 mg — intramuscularly. He was then quickly transferred by ambulance to a burn unit without any consultation between the physicians involved.

After an ambulance ride of 90 minutes, he arrived at the emergency department in an unresponsive state, with feeble slow respirations. His pulse was 140/min. Nasotracheal intubation and ventilatory assistance with a PR-2 Bennett ventilator was immediately instituted. Venous cutdowns at the forearm and groin were performed to administer sodium containing solutions after obtaining the required blood tests. A nasogastric tube was inserted to empty the stomach. A Foley catheter yielded only 5 cc of urine. The burns were all subdermal

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event happen. Once it is over, transport the mother, baby, and somewhat shaken EMT to the hospital.

Driving is the most important part of any ambulance service, EMS system, or rescue squad. Without the driver the unit goes nowhere, no treatment is rendered, no patients are transported, and emergency care at the scene of the accident is an idea instead of a reality. To do a good job, the driver must remember the basic *do's* of emergency driving:

- Know where you are going;
- Choose the quickest, most direct way to the scene;
- Position the unit carefully and out of traffic;
- Know the victim's injuries and drive accordingly;
- Use the smoothest, most direct route to the hospital.

By following these basic common sense rules, the driver can earn the respect of everyone he works with. Through his efforts the driver can bring the overlooked portion of emergency care into focus.

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and involved about 95% of his body surface area. The eschars were dark brown and black in color and were hard and tight. Wheezes were heard over both lungs. Immediate cruciate escharotomies of the thorax and longitudinal escharotomies of all limbs were carried out with obvious improvement in the respiratory excursions.

The laboratory data showed that the patient was profoundly acidotic —arterial pH was only 7.05. The arterial lactate level was 13 mEq/liter, about six times greater than normal, indicating severe shock and lactic acidosis. He was also hypoxic — arterial PO_2 132 mm Hg while breathing 100% oxygen. Initial wound cultures grew *E. Coli*, *Pseudomonas* and *Flavobacterium.* Chest x-rays showed bilateral parenchymal infiltrates. Despite adequate intravenous fluid administration, he expired a few hours after admission.

The referring hospital emergency room record provided only the following information: Apical pulse 152/min, 20 mg Demerol i.m. Diagnosis: Severe burns. Disposition: Transfer to burn unit.

The patient was transferred without

- Proper assessment of the injuries;
- Administration of oxygen and consideration of endotracheal intubation prior to transfer;
- Performance of a venous cutdown and administration of intravenous fluids;
- Thoracic escharotomies to minimize the respiratory distress;
- Insertion of a urinary catheter;
- Dressings to protect the wounds;
- Nasogastric intubation and emptying of the stomach.

Improved methods of burn care can result in survival of children as badly burned as this one, but the inadequate immediate care given to him precluded any chance of survival. A delay of hours is significant when hypoxia and acidosis exist.