EMERGENCY MEDICAL PLANNING
AND INDUSTRIAL DISASTER

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.

IMPORTANCE OF MEDICAL HISTORY

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, potential serious, non-thermal 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 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 preexisting 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% BSA burns. Oxygen should be given to elderly patients even if the wounds are minor. Oxygen at a flow rate of four liters per minute is all that is needed for most burned patients prior to and during transfer.

Dyspnea and tachypnea may result from subdermal circumferential, constricting burns of the thorax or abdomen which 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.

Varying degrees of ileus may regularly accompany 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 will rarely be needed and should be considered only for 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; percutaneous venous short catheters or needles are usually plagued by an interruption of flow during moments of agitation and as the edema increases.

Thermal injury depletes all of the blood constituents; however, rate and magnitude of loss of each blood component is different. Red cells are initially destroyed by 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 BSA 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. Plasma volume can be reduced by one-half in the first two hours postburn or by one-fifth after five hours despite 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 not and should not be administered initially to most burn patients, as it can cause further increase in blood viscosity and impede capillary circulation. But it 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 hyperpermeability, which results in massive extravasation of water, salts, proteins, and even erythrocytes into the wound. This abnormal hyperpermeability of the capillaries usually persists for 36-48 hours. Some physicians 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 postburn hypovolemia is expensive and unnecessary. The worldwide trend is away from the use of colloid. On theoretical grounds, the exogenous plasma proteins can be expected to share the same fate as endogenous proteins: to accumulate in the wound where they increase tissue oncotic pressure and thus tend to exaggerate and prolong edema. More importantly, no one has proved that the use of colloid increases either quality or rate of survival.

Salt water therapy on the other hand, replenishes the predominant losses, is readily available, and is inexpensive. Sodium, the principal osmotically active cation of the extracellular space, plays the major role of maintaining and restoring 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 mEq sodium/liter) is usually administered at 4 cc/kg/% burn in the first 24 hours, but its use often causes 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. 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 as compared to Ringer's. 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% BSA. It should be administered at a rate that maintains a urine flow of 30 cc/hr in adults. Glucose should not be initially administered, as stress hyperglycemia is usually present; 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 to 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 contaminate the eschars and produce wound sepsis. Washing or scrubbing with soap or "antiseptic" solutions should be avoided in order to prevent 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; note carefully the speed of capillary filling, presence or absence of distal pulses, and whether sensory or motor nerve deficit exists. Doppler ultrasound may be used to detect weak pulses and to read inaudible blood pressures.

Circumferential burns of the leg can cause foot drop due to compression of the neurovascular bundle by increasing edema in the anterior compartment; loss of digits or the hand may follow burns of the upper limb. Such complications can be prevented by generous escharotomy performed prior to transfer; one should achieve about two finger breadth separation of the cut eschar edges, carrying 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 surrounding 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% BSA. Smaller 2° burns in the elderly and in children less than five years old are preferably hospitalized because of 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 potentially 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 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% BSA 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.

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