

Review Article

Unfavourable results in acute burn management

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ABSTRACT

An etiology based classification has been devised to innumerate all possible unfavorable results (complications) which may occur during acute burn management. Various factors, right from the onset of burns, may affect the final outcome. These factors, starting from the onset of burns till the occurrence of complication, have been discussed in details. Unfavorable results in regional burns (chest, limb, eye, ear, and hand) have been discussed. Unfavorable results in various chemical burns have been described with necessary precautions to prevent. Various septic complications have been narrated and their prevention is also discussed.

KEY WORDS

Acute burn management; complications in burns; unfavorable results in burns

INTRODUCTION

The ultimate aim of Burn Care is to achieve wound closure without complications. In spite of several advancements in Burn Care, unfavorable results do occur. Some of them are avoidable and some are not. There is a need to pinpoint the avoidable causative factors throughout the phase of acute burn management, i.e., initial two weeks post-burn period. Proper understanding of these factors, preventive measures, and treatment protocol for the unfavorable results need to be emphasized.

The acute phase of burns is defined as a period extending from the onset of burns with shock to the time taken

for wound epithelialization which normally takes about 12 to 14 days, if management of burns is adequate.^[1] The first 48 is the period of shock. With adequate fluid resuscitation this phase merges into the phase of hyper metabolic activity which lasts for about 1 week.^[1] By the end of second week, epithelialization occurs in second degree burns and granulation tissue forms in third degree burns provided slough has been excised. Hence, all unfavorable results or complications that can take place during initial 2 weeks can be included in this subject.

Classification

Unfavorable results (Complications) can be broadly grouped under five heads.

- Those due to improper First Aid
- Those due to improper fluid resuscitation
 - Delayed transfusion or under transfusion causing extension of shock
 - Over transfusion causing edema related complications
- Those due to circulatory insufficiency
 - Gangrene
 - Crush Syndrome

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- Those due to absorption of chemicals through the skin
- Those originating from infection
 - Septicemia
 - Disseminated intravascular coagulopathy (DIC)
 - Multiple Organ Failure (MOF).

The various factors responsible for unfavorable results are as follows.

First aid in burns

Pouring water on burns immediately after burns (during initial 2 min) is considered best First Aid. But one should not immerse severe large burns or whole body in cold water as it is likely to cause hypothermia. Common practice of rubbing with ice is also hazardous since ice is likely to cause cold injury and damage skin further.^[2] No colored topical agent (like ink, gentian violet, mercurochrome, tooth paste etc.) should be applied as it is likely to interfere with evaluation of burn depth and extent. With proper first aid we may not be able to reduce the extent of burns but certainly the depth can be controlled by prolonged cooling of the burnt skin surface.

Transport

India is a vast country with 80% population in villages, whereas most of the burn units (total 42) are located in metro cities. The roads and transport system are far from satisfactory. In quite many remote places it takes several hours for a burn victim to reach burn unit. Often it is seen that burn victims become severely dehydrated when they reach the burn unit. Proper education of medical officers at PHC and district hospital level regarding basics of IV fluid requirement in burn cases can prevent this complication. A nurse should accompany major burn cases during transport to ensure fluid resuscitation during transfer in ambulance.

Assessment of burns

Proper assessment is required to be done immediately after admission because all subsequent treatment is based on it. Life threatening injuries must be treated first. Improper assessment of percentage of burns cause improper amount of fluid administration. Inadequate fluid administration shall not correct burn shock and over transfusion may result in pulmonary fluid overload. For assessment of percentage of burns, all cloths should be removed and examination should be carried out in good light. Patients of respiratory burns with respiratory distress are urgently treated with intubation and

ventilatory support. In all facial burn cases and in cases with history of burns in closed room, higher degree of suspicion is required. One should be prepared to take necessary steps once respiratory problem appears. Mortality in respiratory burns is high but it can be reduced by proper assessment and taking necessary steps as soon as oxygen saturation falls.

Fluid resuscitation

The main aim of resuscitation is to maintain tissue perfusion to the zone of stasis and to prevent the deepening of burns.^[3] If resuscitation is carried out urgently the circulatory shock is not only prevented, none of the complications of shock are allowed to manifest. Under transfusion will result in hypo perfusion and over transfusion will lead to edema causing tissue hypoxia. Indwelling urinary catheter should be inserted in all moderate and major burns and fluid volume should be adjusted according to urine output (minimum 30-35 ml per hour in adults and 1 ml per Kg body weight per hour in children).

The greatest amount of fluid loss in burn patients is in the first 24 h after injury. For the first 8-12 hours, there is a general shift of fluids from intravascular to interstitial fluid compartments.^[4] This means that any fluid given during this time will rapidly leak out from intravascular compartment. Colloids given during this period shall also leak out and produce marked tissue edema. Hence, colloids are generally avoided during initial 24 h.

In small children, especially less than 5 years of age, it is important to administer 5% dextrose during resuscitation in addition to the calculated formula of lactated Ringer's solution.^[5]

Ringers lactate is considered most appropriate physiological fluid because its composition resembles with that of intracellular fluid. Lactate gets converted into bicarbonate in liver which prevents acidosis. Fluids should be free of glucose since glucose intolerance is present due to high circulating level of stress hormones.^[6] However, in small children below 2 years age, due to low storage of glycogen in liver, one should give glucose (to prevent hypoglycemia) along with sodium containing fluids.^[7] The time frame of fluid resuscitation is to be calculated from the time of burn and not from the time of admission in the hospital.

In extensive burn (more than 60% of total body surface), especially in elderly patient or in cases with inhalation

injury, one should be bit conservative in pushing fluids to avoid edema induced complications. However, some workers^[8] believe that patient with severe inhalation injury may require 48-50% more fluid to achieve adequate tissue perfusion. A word of caution - such cases should be carefully monitored. CVP monitoring in such cases is necessary to prevent unfavorable results. The CVP in large burn at this stage is usually low, 0 to 5 cm H₂O even with adequate fluid resuscitation. Therefore, it can be very dangerous to use an arbitrary value of central venous pressure as an end point of resuscitation.^[9]

FLUID RESUSCITATION IN CHILDREN

Body surface area to weight ratio is greater in children. This contributes to greater evaporative water loss. Hence, children may require additional fluids during resuscitation.^[10] Daily maintenance fluid requirements in children is higher than adult. The additional fluids required should preferably be given orally. Grisolia *et al.*^[11] recommend that the administered fluid should have low sodium concentration. We in our practice prefer to give Dextrose- Saline (0.45%) in small children.

LOCAL CARE IN BURNS

Unfavourable results in chest burns

One should look for circumferential deep burns of chest to carry out, if required, emergency procedures like escharotomy. Circumferential full thickness burns of chest may cause impaired chest compliance. As more subeschar edema develops, significant respiratory effort is required to maintain adequate gas exchange. The first clinical evidence of the impaired chest wall compliance is labored breathing followed by rapid respiratory deterioration. This complication can be prevented by doing escharotomies on chest. Vertical incisions along anterior and posterior axillary lines should be made under sterile conditions in operating theatre. If sufficient chest expansion does not occur, further incisions in the mid line and mid clavicular lines and transverse incisions may be required. The incisions should go completely through the eschar up to the deep fascia and the veins must immediately fill up once incisions are made. The bleeding points must be coagulated and a bulky dressing applied.^[12]

Unfavourable results in limb burns

In circumferential full thickness burns of extremity, there occurs increase in pressure under the dead inelastic

eschar which initially decreases the venous return. Fluid resuscitation further increases swelling of tissue beneath the eschar and increases subeschar pressure. This, if not attended early, may lead to gangrene of the distal part. Timely done escharotomy shall prevent this dreaded complication. The escharotomy incision should divide only burn tissue, not the underlying fascia. This differentiates it from fasciotomy. Incisions are made along with lateral or medial aspects of the limbs, avoiding any underlying structures. Anesthesia is generally not necessary as the full thickness burn is insensate. Incision should be deep enough to allow separation of edges thereby permitting bulging of viable tissue. Minor bleeders are electro coagulated and major bleeders are ligated. After escharotomy monitoring of distal perfusion should be continued and if impairment persists, existing escharotomies should be extended or additional escharotomies be performed.

High voltage electric injuries of limbs should be carefully watched for distal vascular integrity and compartment syndrome. Gangrene is quite common. Once gangrene has occurred, amputation should be done earliest. Since deeper muscles sustain greatest injury, crush syndrome and renal failure are common complications. Urgent surgical intervention in this form of fasciotomies and muscle compartment exploration under anesthesia is necessary. All dead muscles should be excised. Besides early fasciotomy, fluid resuscitation demands extra attention. If the urine is rose pigmented from hemochromogens, the urine output should be maintained at 100-125 ml/hour in adults or twice the normal hourly rate in infants and young children, until gross pigment is cleared. The urine can be alkalized by IV administration of sodium bicarbonate to prevent myoglobin precipitation. In severe injuries IV Mannitol are given to promote osmotic diuresis. Early use of other diuretic is contraindicated.^[13]

Unfavourable results in eye burns

Corneal ulcers are often missed if careful examination of both eyes is not carried out. Once corneal ulcer is detected, an ophthalmologist's opinion should be obtained. Early tarsorrhaphy should be avoided as it increases lid deformity and prevents serial examinations of the corneal surface.

Unfavourable results in ear burns

Chondritis leading to cauliflower deformity of Pinna is common complication in ear burns. Pressure is the biggest co-factor in the production of chondritis. Hence,

pressure on the burned auricle (pillows) should be avoided. Proper dressing of Pinna with mastoid dressing is essential till healing is complete. Occasionally, when cartilage is exposed, coverage with temporoparietal facial flap and skin graft may be required to salvage the pinna.

Unfavourable results in hand burns

Apart from vascular complications, burnt hand is prone to several other complications like massive edema, contractures, deformities of fingers, and stiffness. Most of these complications are preventable. During initial 48 h circulation in fingers should be checked frequently. Escharotomy or fasciotomy should be carried out if necessary. Each finger should be dressed individually (to prevent syndactyly). Hand should be splinted in position of function, i.e., MP joints in 70-90 degree flexion, the I.P. joints in extension, thumb abducted and wrist at 20° extension. The hands should be elevated to minimize edema. Physiotherapy should be started early. In cases of burns causing tendon injuries in fingers, one should look for development of Boutonnieres and Mallet finger deformity at earliest stage. In suspected cases specific splints meant for the prevention of these deformities should be used at early stage. Deep dermal and full thickness burns should be treated with early excision and skin grafting.

Unfavourable results in chemical burns

Most of the chemical agents (acids, alkalis etc.) cause local tissue damage. However, some chemicals especially organic compounds get absorbed quickly from skin and affect different organs. For example phenol gets absorbed from skin and leads to renal failure. Heavy metal poisoning occurs by absorption of organic metal complexes. Usually, the amount of damage in chemical burns is more extensive than thermal burns because the chemical agent causes progressive damage till it gets inactivated by tissue reaction.^[14]

Phenol (Carbonic acid)

It is used as an antiseptic agent. Sometimes perineal burns caused by phenol are seen. The phenol bottle kept in the toilet may accidentally be mistakenly used for perineal ablutions. Burns could be superficial or deep depending upon the concentration of phenol. But due to absorption, systemic effects develop like depression of CNS, cardiac arrest, renal failure, and jaundice. Prompt treatment is required which includes copious lavage with water (shower bath). Deep burns should be immediately excised and skin grafted.

Hydro fluoric acid

It is strong inorganic acid used as a metal and glass cleaning agent. It releases hydrogen ions and fluoride ions. Former produces coagulation necrosis while later penetrates through the cell membrane and binds to calcium and magnesium in the cells and releases potassium which irritates nerve endings causing severe pain. The amount of pain is usually out of proportion to the area of burn. It may cause gangrene of fingers if not treated promptly. Treatment includes washing the burnt area with water as early as possible and thereafter rubbing the area with 2.5% calcium gluconate gel for 15-20 min till pain subsides. This gel converts fluoride ion into calcium fluoride. Alternatively, 10% calcium gluconate can be injected under the eschar.

Chromic acid

It is used in electroplating and dye industry. It acts through chromium ions which penetrate cell membrane and cause coagulative necrosis. The burns may become full thickness as it causes no pain. Systemic effects due to its absorption may come up in the form of renal failure, hepatic failure, CNS involvement etc. Treatment includes washing the affected area with copious water irrigation followed by use of phosphate buffer soaks. Mortality in such burns can be reduced by excision of full thickness area and skin grafting at early stage.

Unfavourable results in electrical injuries

Electrical injury is not just an electrical burn. It can cause devastating multisystem trauma. Most of these injuries are preventable with some precautions.

High voltage electrical injuries

High voltage electrical injuries of the extremities are at the risk of development of compartment syndrome during the first 48 h post injury.^[15] Damaged muscle and swelling within the investing fascia of the extremity may increase pressure to the point where muscle blood flow is compromised. Loss of pulses is one of the last signs of compartment syndrome unlike the early loss of pulses occurring in a circumferentially burned extremity requiring an escharotomy. Several diagnostic tests have been mentioned in literature like using variety of catheter techniques, radionuclide scanning, and magnetic resonance imaging etc. These tests are not only expensive but cumbersome and unnecessary. A high index of suspicion is paramount for the early diagnosis of compartment syndrome. Once diagnosis is made, aggressive fasciotomy of the affected limb in

the operating theatre is the treatment of choice. Apart from compartment syndrome, other primary early complications of high voltage injuries are renal failure and infection. These can be prevented by adequate resuscitation and rapid removal of necrotic tissue.

High voltage injuries of chest wall present special closure problems for coverage of exposed bone and cartilage. Costal chondritis is the most common complication responsible for long term morbidity. Abdominal wounds need careful planning and multidisciplinary team for optimal results.

Low voltage electrical injuries

Low voltage direct current can cause both direct injury and as well as thermal injuries quite often causing circumferential thermal burns due to ring, wrist watch, bracelet etc. Low voltage alternating current injury is usually localized to the points of contact. Children are very prone to get such burns on palm, fingers, and peri-oral region. Though localized, most of these burns require excision and skin grafting to prevent infection and to reduce morbidity.

Unfavourable results in radiation injuries

There are three types of causes of radiation injuries.

- Small scale accidents which may occur in Hospital due to exposure to some X-ray or radiation device
- Large scale accidents which may occur in industries like energy generating nuclear reactors and in some industries where radioactive isotopes are used
- Detonation of nuclear bomb in war.

Exposure to radiation causes both thermal and radiation injuries. They could be either localized or affecting whole body (acute radiation syndrome). The depth of localized injuries depends upon the dose of exposure and the surgical treatment varies accordingly. Neglected radiation injuries may lead to skin cancer after months or years.

Chronic pain, nausea, and vomiting are common symptoms. Analgesics and antiemetic are to be used. Extensive radiation injuries are to be treated with IV fluids (as in thermal burns). However, the fluid requirement is increased because the fluid is sequestered into damaged internal organs especially the gut.^[16] Non-healing wound is common complication. Definitive management involves resection of damaged tissue and replacement with well vascularized non-radiated tissue, preferably from a distant site. Hyperbaric oxygen therapy (HBO) may be

combined with surgical treatment to enhance wound healing. Infection is common in irradiation injuries due to immunosuppression. Immunosuppression is treated with bone marrow transplantation.

Early excision in burns

I personally feel that early excision and grafting of the major burn wounds as practiced in the west is not easy to implement with the facilities available even in the best hospitals in our country. That does not mean that it is not desirable. The only option left for most of the Indian Burn Surgeons is to practice delayed excision and grafting.

Septic complications

Septicemia

The devitalized burnt tissue provides platform for rapid growth of bacteria. The consequent complications of invasive sepsis and septicemia can greatly be prevented by aseptic dressings right from the beginning. Early excision and grafting prevent septic complications in full thickness burns.

Disseminated intravascular coagulopathy

There occurs fall in platelet count (thrombocytopenia) due to burn sepsis. Platelet aggregation also occurs in the damaged capillary endothelium. These micro thrombi have a capacity to consume the coagulation factors. The result is spontaneous bleeding from various sites like gastrointestinal tract. This is known as DIC. Platelet transfusion is given to control the condition but so long as infection persists, the condition can reappear.

Multi organ system failure or Multi-organ Dysfunction Syndrome

Is defined as a process, wherein after acute burn regardless of the TBS involved, system by system fails to function resulting in death of the patient. This is the major cause of death in acute burns. The systems commonly affected are lungs (Adult Respiratory Distress Syndrome), kidneys, liver, cardiovascular system, central nervous system, and the blood coagulation system. These may fail singularly or two or three systems fail together resulting in the calamity. There are several theories postulated toward MOF. However, infection and endotoxin theory is commonly believed because infection is the usual accompaniment of major burns. Endotoxin absorption from the intestines is also responsible. Sepsis initiates micro thrombi formation and intravascular coagulation. The management of MODS in burns encompasses a few salient principles, prevention of MODS being the

ultimate goal because once certain stage of systemic inflammation is reached, set protocols of management fail to make a significant effect, treatment becomes empirical, and prognosis poor.^[17] The various preventive steps are adequate timely resuscitation, early excision and coverage, preservation of gut mucosal barrier by maintaining adequate perfusion and enteral feeding, prompt management of inhalational injuries, management of the pre-existing co-morbid conditions like Diabetes and maintaining peripheral oxygen delivery.

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