IOSR Journal Of Pharmacy And Biological Sciences (IOSR-JPBS)
e-ISSN:2278-3008, p-ISSN:2319-7676. Volume 14, Issue 4 Ser. I (Jul – Aug 2019), PP 75-80
www.Iosrjournals.Org

Managing Burns and Related Complications in Emergency

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Abstract- *A burn is a thermal injury caused by biological, chemical, electrical and physical agents with local and systemic repercussions. They have a greater incidence in economically and culturally marginalized countries. Knowing the kind of burn is vital for effective management. Following a burn, there's a huge production of free radicals that is harmful and involved in inflammation, systemic inflammatory response syndrome, immunosuppression, infection and sepsis, tissue injury and multiple organ failure. The aim of first aid is cessation of the burning process, cool the burn,(relieve the pain),and cover the burn. Treatment with cutaneous grafts focuses on avoiding granulation phase where there is contraction of wound. The definitive treatment of burns is tangential excision and early grafting, since they are the only measures that decrease the metabolic demand, infections, hospital stay and morbidity. Basic science studies have slowly begun to uncover the complex mechanisms involved in the systemic response to burn.*

Key words- *Burns, severity assessment, fluid resuscitation, excision, skin grafting, nutrition*

Date of Submission: 11-07-2019 Date of acceptance: 26-07-2019

I. Introduction

Burns are devastating injuries, typically leading to significant morbidity, impairment of emotional well-being, and interfere with quality of life. Additionally to the nerve-racking immediate care, burns typically need long term with varied patient visits (dressing changes etc.) and multiple reconstructive surgical procedures ± concomitant hospital stays. These health related consequences of burns are typically associated with further socioeconomic burdens for burn victims and their families.[1-5] Risk factors for burns embody those associated with socioeconomic standing, race and quality, age, and gender, moreover as those factors pertaining to region of residence, intent of injury, and comorbidity.[6] The World Health Organization estimates that the life time incidence of severe burns is 1% and that more than three hundred thousand individuals die annually from fire-related burns worldwide As the treatment of burn injuries might need months to years, with recurrent intervening surgical procedures, it is obvious that burn injuries continue to represent a notable medical, economical, and social challenge for a developing country.[7]

Types of Burns: Knowing the kind of burn is vital for effective management. Different causes lead to different injury patterns that need different management.

a) *Thermal burns:*

Scalds- Common mechanisms are spilling hot drinks or liquids or being exposed to hot bathing water. Scalds tend to cause superficial to superficial dermal burns.

Flame- They're typically related to inhalational injury and other alternative concomitant trauma. They have an inclination to be deep dermal or full thickness. [8]

Contact- Largely because of contact with radiators, irons, hobs & hair straightners.

Flash- Ignition of a volatile substance, mostly after using accelerants once burning rubbish.

b) *Electrical burns:*

Low voltage – because of domestic electrical provides<240volts.

High voltage – power of cables >1000volts.[9]

Lightning –comparatively uncommon however present complaints that don't seem to be essentially distinctive. Respiratory or cardiopulmonary arrest is the most immediate life threatening complication. [10]

c) *Chemical burns:*
White phosphorous is the most typical causative agent. Acids, alkalis and organic solvents are other alternative common causes of injury. Systemic toxicity and inhalational injury are however typically severe and increase mortality.[11]

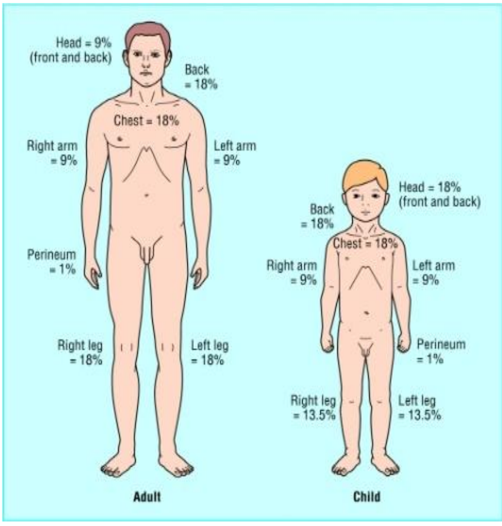
d) *Radiation burns:*
Ultraviolet light- Sun, tanning booths. These burns vary greatly with skin type.
Ionizing radiation – radiation therapy, X- rays, radioactive fall out. Severity is expounded to volume of exposure.[9]

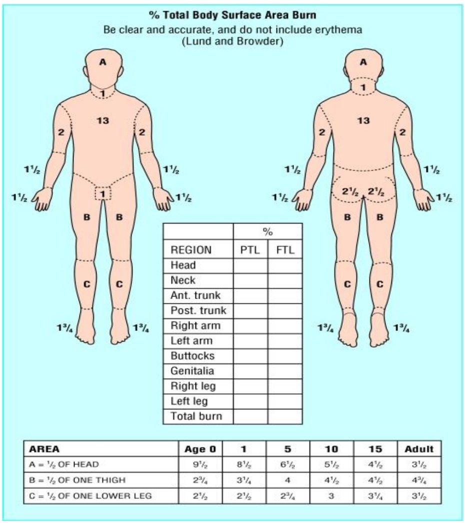
Mechanism of Burn injury:
A severe burn is accompanied by release of inflammatory mediators that ultimately cause native and distant pathophysiological effects. Mediators as well as reactive oxygen species and reactive nitrogen species are elevated in affected tissues that are implicated in pathophysiological patients. Following a burn, there's a implicated in pathophysiological patients. Following a burn, there's a inflammation, systemic inflammatory response syndrome, immune suppression, infection and sepsis, tissue injury and multiple organ failure. This clinical response relies on the balance between production of free radicals and its detoxification. Both elevated xanthine oxidase and activation of neutrophils seem to be the oxidative sources in burns. [12]

Conditions related to burns:

i. ***Hypovolaemic shock-*** This is induced by loss of plasma from blood vessels. The key reason for this can be increase in vascular permeability stimulated by inflammatory mediators & increase of vascular hydrostatic pressure caused by vessel dilation.[13]
ii. ***Hypothermia-*** Patients with burns might have thermoregulatory compromise because of substantial injury to the integumentary structure. As a result, they're not anymore able to maintain core temperature and start to cool much quickly leading to hypothermia.[14]
iii. ***Infections-*** The body tries to conserve homeostasis by initiating a process of contraction, retraction and coagulation of blood vessels quickly following a burn injury. Serious thermal injury causes total loss of skin surface over large areas of the body. the chance of resultant burn wound infection and systemic infection correlates with the extent of burn injury.[15]
iv. ***Keloids-*** Keloids infiltrate into nearby unaffected tissue and hardly regress. Once wound repair is completed, the activity of TGF-β is generally turned off. In keloidal tissue, TGF-β is overproduced and poorly regulated. Less synthesis of molecules that promote matrix breakdown (e.g.- MMPs) might also describe the absence of scar regression seen in keloids.[16]
v. ***Contractures-*** Burn scar contractures will cause a poor functional and cosmetic outcome and also possible psychological consequences. Myofibroblasts proliferate at a wound area that causes the wound edges to contract towards each other. Delayed healing and scar formation results in over proliferation of myofibroblasts inflicting pathological contraction.[17]

Severity Assessment of Burns:
There are 3 frequently used approaches of estimating burn area, and each encompasses a role in numerous situations. When calculating burn area, erythema or redness shouldn't be taken in. This may take some hours to fade, thus some overestimation is inevitable if the burn is calculable acutely.



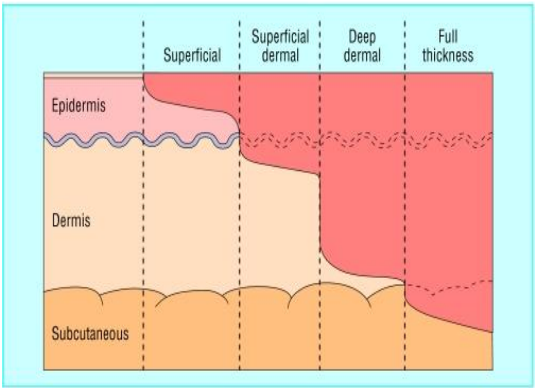


Palmar surface —
The surface area of a patient's palm (including fingers) is approximately 0.8% of total body surface area. Palmar surface area can be used to estimate relatively small burns (< 15% of total surface area) or very large burns (>85%, when unburnt skin is counted). For medium sized burns, it is inaccurate.

Wallace rule of nines —This may be a sensible, fast method of estimating medium to large burns in adults. The body is divided into areas of 9%, and the total burn area can be calculated. It is not accurate in children.(Figure A)

Lund and Browder chart —This chart, if used correctly, is the most accurate method. It compensates for the variation in body form with age and so will provide a correct assessment of burns area in paediatrics.(Figure B)

Classification of burn depths:



Burns are classified into 2 types by the volume of skin loss. Partial thickness burns do not extend through all skin layers, whereas full thickness burns extend through all skin layers into the subcutaneous tissues. Partial thickness burns can be additionally divided into superficial, superficial dermal, and deep dermal:

a. Superficial—The burn affects the epidermis but not the dermis (such as sunburn). It is often called an epidermal burn.
b. Superficial dermal—The burn extends through the epidermis into the upper layers of the dermis and is associated with blistering.
c. Deep dermal—The burn extends through the epidermis into the deeper layers of the dermis but not through the entire dermis.[18]

First Aid of Burns:
The aim of first aid is to stop the burning process, cool the burn, provide pain relief, and cover the burn.[19]

- **a.** Stop the burning process—The source of heat ought to be removed.
- **b.** Flames ought to be doused with water or smothered with a blanket or by rolling the victim on the ground.
- **c.** Clothing will retain heat, even in a scald burn, and should be removed as soon as possible.
- **d.** Adherent material, such as nylon clothing, should be left on.
- **e.** In the case of electrical burns the victim should be disconnected from the source of electricity before first aid is attempted.[19]
- **f.** Cooling the burn—A study by Yuan et al showed that cool running water applied right away after for 20minutes period to porcine burns typically reduced the histologic depth of injury over the course of 9 days compared to wet towels (refreshed every 3 minutes), water spray(delivered every 30seconds) and an untreated control.[20]
- **g.** Analgesia—cooling and simply covering the exposed burn will reduce the pain. Opioids may be required initially to control pain.
- **h.** Covering the wound – the burnt part should be wrapped in a clean, dry sheet/cloth. Pillow cover/plastic bags are suitable for upper and lower limb injuries. Plasticised polyvinyl-chloride film available as a food-wrap is a good alternative to cover the burned areas. [21]

Management of Burns:
Fluid resuscitation – Sodium salt solutions (crystalloids) are the important constituent of fluid resuscitation. Lactated Ringer's solution has been the most widely used of the solutions.[22]
Parkland formula for burns resuscitation
Total fluid requirement in 24 hours =
4 ml×(total burn surface area (%))×(body weight (kg)).
50% given in first 8 hours.
50% given in next 16 hours.
Children receive maintenance fluid additionally, at hourly rate of4 ml/kg for 1st ten kg of body weight +2 ml/kg for 2nd ten kg of body weight +1 ml/kg for > twenty kg of body weight.
End point-
Urine output of 0.5-1.0 ml/kg/hour in adults.
Urine output of 1.0-1.5 ml/kg/hour in children.[18]

Inhalational injury –
Injuries to the airways and lungs are principally the result of exposure to chemicals during building or vehicular fire. A variety of harmful incomplete products of combustion are inhaled. Carbon monoxide is commonly inhaled.[22]The simplest and probably the best treatment for carbon monoxide poisoning is ventilation with 100 percent oxygen, which decreases the half life of carboxyhemoglobin from 4¼ hours to about 50 minutes.[23]

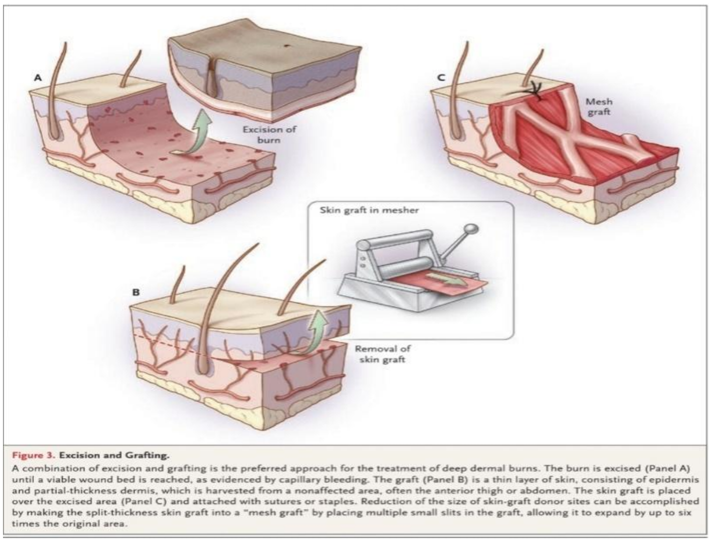


Figure 3. Excision and Grafting.
A combination of excision and grafting is the preferred approach for the treatment of deep dermal burns. The burn is excised (Panel A) until a viable wound bed is reached, as evidenced by capillary bleeding. The graft (Panel B) is a thin layer of skin, consisting of epidermis and partial-thickness dermis, which is harvested from a nonaffected area, often the anterior thigh or abdomen. The skin graft is placed over the excised area (Panel C) and attached with sutures or staples. Reduction of the size of skin-graft donor sites can be accomplished by making the split-thickness skin graft into a "mesh graft" by placing multiple small slits in the graft, allowing it to expand by up to six times the original area.

Excision and skin grafting –
This approach removes dead and inflamed tissues and quickly promotes physiologic wound closure. Early excision and grafting have been shown to reduce inflammation, as well as the risks of infection, wound sepsis, and multiple organ failure.[24]

Nutritional assessment –Aggressive nutrition support is suggested following severe burn injury. Initially, such injury leads to a extended and continuous hyper metabolic response mediated by a 10 to 20 fold elevation in plasma catecholamines, cortisol, and inflammatory mediators. This response results in twice-normal metabolic rates, whole-body catabolism, muscle wasting, and severe cachexia. Thus, it is appropriate to review the literature on nutrition in burns to adjust/update treatment. Failure to meet the increased substrate requirements may result in impaired wound healing, multiorgan dysfunction, increased susceptibility to infection, and death.[25]

Newer Developments:
Advances in fluid resuscitation- There has been a resurgence of interest in oral resuscitation in treatment of moderate burns in wake of terrorist induced massive burn situations. Resuscitation with hypertonic saline has been trialled by a number of groups. Purported benefits include sustained reduction in peripheral and visceral edema, better organ perfusion, improved myocardial function.

New therapies in smoke inhalation- Smoke inhalation could lead to a demand for mechanical ventilation. Wide bore tracheostomy tubes, bronchoscopy and airway toilet are needed more frequently in smoke inhalation group. A pro coagulation tendency has been observed in animal models of smoke inhalation. Pending the results of these trials, some recommend the use of nebulised heparin.

Topical treatments- The most commonly used antimicrobial in the developed world is Silver Sulfadiazine (SSD). In Australasia, SSD is combined with Chlorhexidine. Nanocrystalline silver dressings are now utilized in many countries. Cerium dressings are popular in United Kingdom and there are some reports that their application may allow chelating of toxic products of the burn wound, diminishing the development of SIRS in large burn wound.[26]

Skin bioprinting- Skin bioprinting technology has great potential to facilitate fabrication of physiologically-relevant tissue and allow better and more consistent practical results in burn patients.
The use of bioprinting for skin reconstruction following burns is promising, and bioprinting will enable accurate placement of all the different native skin cell types and precise and reproducible fabrication of constructs to replace injured or wounded skin. The use of 3D bioprinting for wound healing will facilitate faster wound closure, which is critical in the case of extensive burn injuries. Further advances in terms of development of standardized clinical grade 3D bioprinters and biocompatible bio inks will enable wider use of this technology in the clinic.[27]

II. Conclusion

Prevention of burn injuries, based on the epidemiology of burn in developing countries, remains a major way of reducing the current spate of morbidity and mortality in our patients.[28] Basic science studies have slowly begun to uncover the complex mechanisms involved in the systemic response to burn. Clinical trials are still largely limited to the assessment of managing and treating burn injuries. Translation of results from basic science studies to improved clinical therapies for treatment of burn victims has been modest, and increased numbers of clinical trials of novel therapeutic approaches for burn should be a priority in the years ahead.[29]

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IOSR Journal of Pharmacy and Biological Sciences (IOSR-JPBS) is UGC approved Journal with Sl. No. 5012, Journal no. 49063.

Vallala Akhila. " Managing Burns and Related Complications in Emergency" IOSR Journal of Pharmacy and Biological Sciences (IOSR-JPBS) 14.4 (2019): 75-80.