# National Programme for Prevention and Management of Burn Injuries (NPPMBI)



Courtesy: Bihar Burn & Trauma research centre

## Directorate General of Health Services

## Ministry of Health and Family Welfare

## Government of India

***BURNS PREVENTION IS THE ONLY WAY TO REDUCE INCIDENCE OF BURNS.***

# Index

# 1. SKIN & ITS PROPERTIES

*UNDERSTANDNG SKIN AND ITS RELATIONSHIP WITH BURN WOUND HEALING*

Skin is a composite structure and the largest organ of human body with multifocal activities.

Functions of skin are:

- Physical barrier & infection control
- Sensation
- Water & electrolyte balance
- Temperature regulation

The skin consists of two layers with different properties. The covering layer/epidermis is the layer which finally completes wound healing. The deeper layer is called the dermis, which is the layer providing strength and stability to the skin. Also this layer contains the pilosebaceous elements.

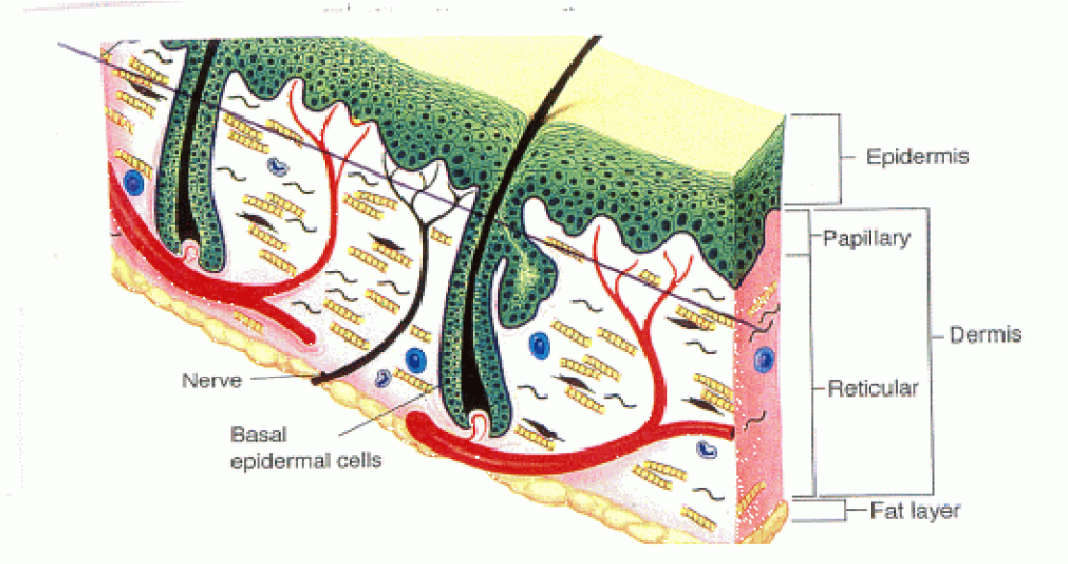



**Figure-1 Anatomy of skin & its layers**

***Epidermis:***

Epidermis is ectodermal by origin and has the capability of complete regeneration and forms the replica of original. Therefore burn which is confined to the epidermis will heal without any tell-tale story in the form of scar.

The basal layer of epidermis encroaches onto the dermis and is seen as papillary structures. These encroachments are often described as dermal elements though in true sense these are epidermal elements. This portion of dermis is described as papillary dermis. Because of the

presence of these epidermal structures this portion of the dermis shows the property of regeneration in combination with repair.

***Dermis:***

Dermis which is devoid of these dermal elements is described as reticular which has no property of regeneration and will always require a reparative process. *Burns involving up to this layer heal mostly by reparative process and may develop hypertrophic scars.*

The proportion of papillary dermis and reticular dermis markedly vary in different parts of the body. For sake of simplification we can say that the amount of papillary dermis is higher on the flexor aspects of the body and amount of reticular dermis is more in proportion on extensor surfaces of the body. However, this is not universal. Face has a rich layer of papillary dermis with comparatively very small layer of reticular dermis; therefore, most burns of the face heal spontaneously.

Because of the limited amount of the epithelial tissue in the deeper layer and because of the limited reticular layer these wounds quickly contract and lead to marked deformation of the facial structure. This is justifiably seen in the formation and development of ectropion in the upper and lower eyelids, webbing around the medial canthus, contraction of nasolabial fold, shortening and contractures of the upper and lower lip with circumoral contraction. Similarly, limitations of reticular dermis which is basically a storing protective layer leads to quick development of contractures of neck on the flexor aspect.

Availability of thick layer of reticular dermis in the back and buttock region is responsible for practically no contracture in the region of back, buttocks and nape of the neck.

## SUMMARY FOR NURSES & PARAMEDICS

- Skin is an essential organ of our body & performs many vital functions.
- Skin is composed of epidermis & Dermis.
- Burns confined to epidermis & superficial part of dermis heal well with no or minimal scarring.
- Burns involving deep dermis heal with hypertrophy and contractures.
- With burns, all vital functions of skin are lost.
- Facial burns almost always heal well due to presence of high proportion of papillary dermis. They should be protected from sunlight.
- Reticular layer of dermis protects against formation of contractures; thin layer over face, eyelid & neck is responsible for development of contractures & thick layer over buttocks & back protects against developing same.

# 2. BURNS - CAUSES & MODES OF INJURY

The various modes for sustaining burns are:

- Flames
- Scalds
- Chemical
- Electrical

**Flame burns**

Mostly accidental, they are frequently due to leaking gas pipe or cylinder and sometimes due to use of kerosene pressure stove. The correct method of lighting the stove is to first sprinkle some spirit over the burner & them pump kerosene vapors below after igniting ; but due to shortage of spirit ,people over-pump kerosene vapor which gets sprayed on the face, clothes & nearby inflammables which compounds the burn injury.

Cooking at floor level along with overcrowding & playing of toddlers in the vicinity are the risk factors for burn injury among children.

Lighting of crackers during ñDiwaliò carelessly or as a part of competition among children often leads to mishaps. Lack of adult supervision associated with adornment of synthetic clothing adds to the problem.

Similar conditions are seen in a ópandalô fire where use of tents in constrained areas during weddings/functions etc. along with improper makeshift kitchens and improper lighting may lead to fire breakout.

**Scalds**

Scald is the most common cause of burns in children. Scalds are often due to negligence by the caregiver when a small child ventures near a vessel containing hot liquid and spills it on himself or herself. Storing of hot water in bathrooms where toddler may accidently slip into the bucket is also a risk factor.

Overcrowding with too many children playing in the same room where mother is cooking on the floor is the most common history elicited when children burns occur.

**Chemical burns**

They are often seen as accidental burns due to spillage of strong sulfuric acid or nitric acid which are majorly used as toilet cleaning agents and available in every household. They are often very devastating injuries claiming vision, appearance or sometimes even the life of the victim. They are also seen as suicidal or homicidal burns when used in order to threaten, demoralize or seek revenge from someone.

## Electrical burns

Almost always accidental, they are most commonly seen in overcrowded localities with illegal electrical wiring, defective electrical sockets and other contributing factors. They are also seen in sub-urban areas as a part of ósealingô electricity by throwing a live wire onto a high tension electric cable.

People travelling on train tops have also sustained electrical injury. Apart from this, ignorant unsupervised children playing at home are often victims of electric burns due to exposed ñliveò wires or short circuits.

## SUMMARY FOR NURSES & PARAMEDICS

- Flame burns are most common cause of burns. All activities involving fire, including cooking should be carried out with utmost care & presence of mind.
- Overcrowding should be avoided; toddlers should be kept away from cooking area.
- Faulty cooking gadgets & illegal cylinders should not be used.
- Hot water should never be stored in buckets, should be used only when required.
- Electric circuits at home should be carefully insulated and kept out of reach of small children.
- In the event of gathering or function, tents should be well planned so that cooking area is away from the crowd specially children.
- Chemicals used for cleaning should be labeled well, kept in closed cupboards and taken out only under supervision.

# 3. CHEMICAL BURN

**(With special reference to Acid attack)**

Chemical burn is caused by corrosive substances such as acids and alkalis. These chemicals are known to cause significant tissue damage when they come in contact with skin surface. A pH of 7 is neutral. Acids are lower in pH and alkalis are higher in pH. Litmus paper can be used to confirm the type of chemical.

**Chemicals causing burn:**

1. Acids- Accidental or due to violence
2. Toilet cleaner
3. Sulphuric acid
4. Hydrochloric acid
5. Chemicals in the industries-
    a. Chemical industries
    b. Mining industries
    c. Fabrication industries
    d. Medical manufacturing units
    e. Cotton industries

**Pathophysiology:**

- Most of the acids produce coagulation necrosis by denaturing proteins. It forms coagulum or eschar. This coagulum is thick leathery layer of dead skin.
- Alkalis though look mild, but produce more severe injury. They cause liquefaction of the tissue. This involves denaturation of proteins and saporification of fat. The effect of alkali remains ongoing and cause increasing depth of damage.

**Depth and severity of burn depend upon:**

1. PH of the chemical
2. Concentration of the agent
3. Duration of the contact with the agent
4. Volume of the agent used
5. Physical form of the chemical agent
6. Involvement of the organ.

**Mode of Injury:**

The effect of the chemicals depend upon the mode of chemical injury. The vitriolage or acid violence is deliberate throwing of acid on someone causing burn over face and upper part of the

body. This is aimed at maiming or disfigure the women and children. Often the eyes are affected because of the direct contact of acid to the cornea and eye ball.

The chemical injuries caused in the industries affect hands and lower part of the body. The chemicals in the industries may have irritant fumes, which cause respiratory burn. Ingestion of chemicals may cause burn of oral cavity, pharynx and oesophagus.

**Clinical features or effects of corrosives:**

The chemical burn is characterised by discoloration of skin with clear line of demarcation. It is brown or black with sulphuric acid and yellow with nitric acid. The trickle marks are the special features. There is absence of blisters. The chemical substance may be present over the surface and the clothings.
The acid burn victim suffers from severe pain and burning. In case of acid attack, the corrosives may enter in the eyes and cause corneal damage. This causes severe pain in the affected eye.

**Prehospital approach to chemical burn:**

S.A.F.E. approach is recommended-
S ï Shout for help
A ï Assess the scene quickly
F ï Free from danger of violence
E ï Evaluate the casualty

**Initial management of chemical burn:**

- Removal of smeared clothes
- Removal of metallic ornaments in and around acid burn area.
- Manual removal of solid chemicals with no touch technique
- Removal or capping of source of chemical
- Irrigation with copious plain water for 15 ï 20 minutes
- Do not try to neutralize the chemical as it may cause exothermic reaction and more damage.
- The rescuer must be careful not to cause harm himself/herself.
- The water should not spill over rest of the normal body parts especially eyes, nose, mouth and ears.
- Many chemical may cause inhalation injury due to toxic chemical vapours. The source of chemical should be capped or removed from the scene.

All chemical burn victims should be rushed to the nearest specialised medical care units at the earliest.

**Management in the hospital:**

1. Copious washing to continue till litmus test is negative.
2. Chemical inhalation burn should be assessed and managed.
3. Treatment of burn area is management of any other burn injury. One has the choice of early surgical excision or conservative therapy.
4. Early excision is preferred for early and better recovery.
5. These burns heal with bad scars and deformities of face and neck
6. These may require secondary surgeries for correction of deformities.
7. Psychological support at every stage of management is essential part of treatment.
8. **Finally rehabilitate to get back to society.**

**Prevention:**

The concerted efforts of media, non-governmental organisations and administration may prevent this social evil of acid attack. The efforts of NGOs has resulted in reduction in the incidence in Bangladesh. They have been able to force many legislative reforms over past few years. The restricted availability of acid and chemicals for general public is one of the effective steps in prevention.

# 4. FIRST AID & TRANSPORTATION

**On site care:**
A burn is because of flame and fire; more the contact with fire more is the extent and depth of burn. First & foremost priority is to safely extinguish the fire expeditiously.
Pouring plain water on fire is the easiest way to douse the flame; however when the burns is due to electricity sand is a better option than water. If water is not available, victim should drop and roll till fire is extinguished.

In case of electrical burns, putting the main switch off as soon as a person has come in contact with an electrical circuit. Futhermore, any attempt to manually separate the victim from electrical source may result in electric burns to the rescuer too; therefore a wooden scale or rod should be used to push the victim away from electricity.

In case of chemical burns, washing the area with copious amounts of ordinary running water for at least half to one hour; reduces the effect of chemical by simple dilution and at the same time removes it from the body.

***First aid:***
Once the patients is away from fire, cooling with running plain water for a short period may help but attempt should be made to quickly transport the patient to the hospital. During the process one must see that the patientôs airway is maintained. Patients who have sustained burn injuries in a closed chamber may develop carbon monoxide poisoning and may require quick cleaning of the throat and putting oxygen mask during transportation. Sometimes in case of electrical injuries, patient may have respiratory/cardiac arrest for which cardiac massage; mouth to mouth breathing/Ambu bag must be used during transportation. Electrical burns respond well to these measures.

***Transportation:*** Transportation of burn victims should be done as quickly as possible, so that the ñg*olden period*ò of resuscitation is not wasted. At the site of injury all attempts should be made to maintain the airway so that the patient is transported safely. At the same time all fractures and probable spinal injuries should be adequately fixed by appropriate collar or neck splintage.

An injured limb should be properly splinted so that no further damage is done during transportation. During transportation a burnt patient, especially infants and children should be kept well covered to avoid excessive heat loss and resulting hypothermia.

## SUMMARY FOR NURSES & PARAMEDICS

- Always take the victim away from site of burns.
- Rescuer should take care of his/ her own safety.
- Electrical injury patients require close monitoring for cardiac arrhythmias.
- Ensure A-Airway-Breathing & C-Circulation before transportation to higher center.
- Always rule out head injury, cervical spinal injury, other limb injury before transporation; if any of these is present, shift with adequate precaution in the form of cervical brace, limb splint etc.
- In case of chemical burns, wash the wound with copious saline.

# 5. BURNS-EXTENT & SEVERITY

*UNDERSTANDING ESTIMATION EXTENT & SEVERITY OF BURNS*

Burns is a three dimensional injury. Severity of burns depends upon quantum of tissue burnt and depth. Whole body surface area is taken as 100%. Proportion of surface burn is represented as %age.

**Estimation of surface area**

There are many ways to estimate surface area burned. None of these are 100% accurate. Rule of Nine which was popularized by A.F. Wallace of Edinburgh remains the most popular method of describing the surface area burn. In this, body is divided into 11 equal parts making this 99% and 1% is given to perineum. (Figure 2)

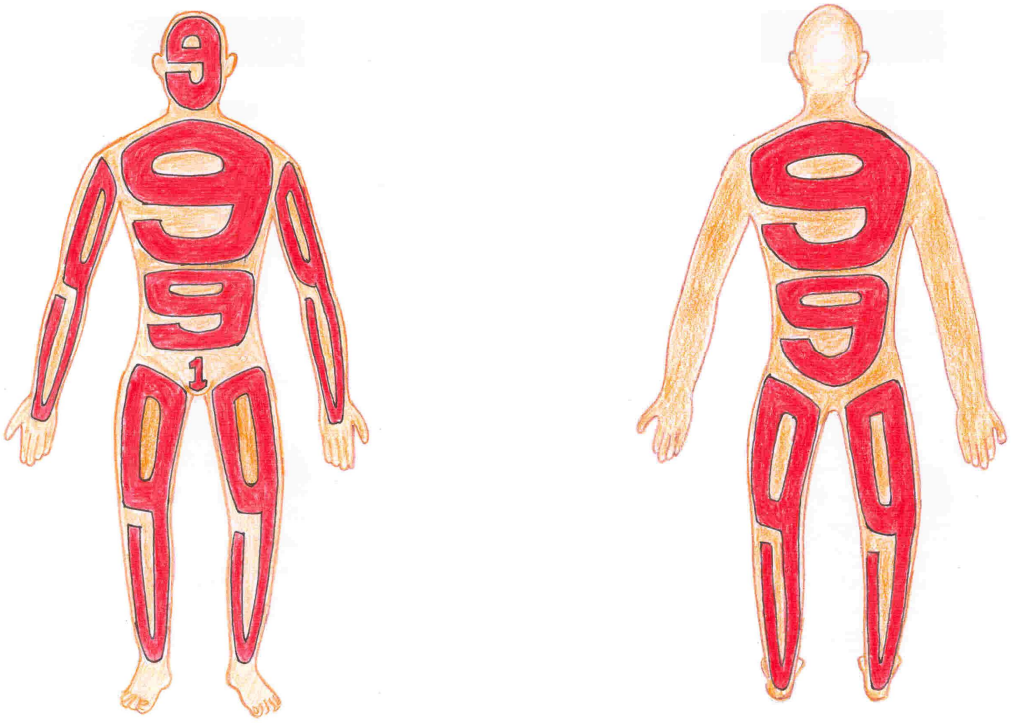
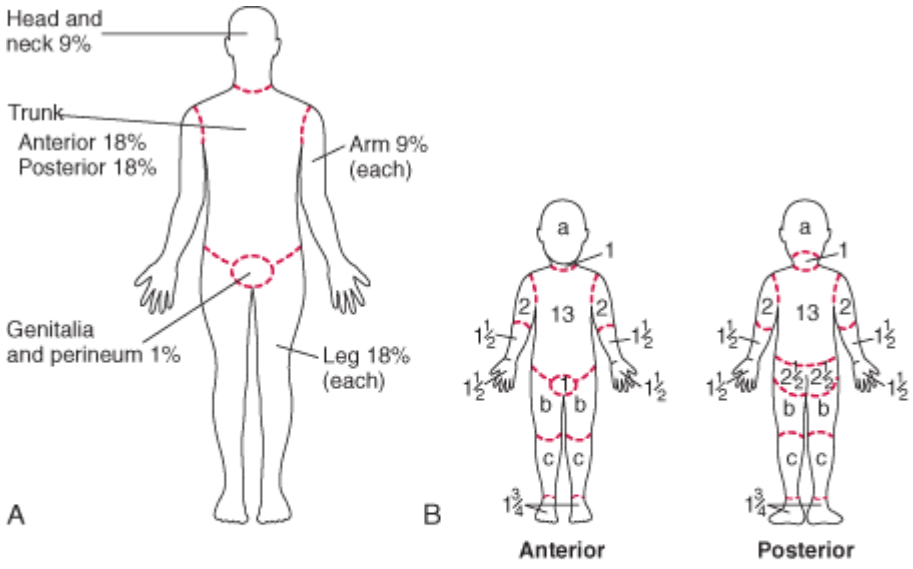



**Figure-1 'Rule of Nine' for estimation of TBSA burned**

In new borns and children, because of the larger size of head and small body surface area of limbs, the Rule of Nine is not applicable. Lund and Browder chart simplifies the calculation of total body surface area burn in children. This takes into account the variation in the body surface area of different parts of the body in different age group.

Also, it is common to see patchy burns making calculations a difficult proposition. For this, more elaborate chart was proposed by Lund and Browder which also takes in consideration the patientôs age for calculation of surface area of burns involved. This appears to be the most

accurate method so far available but it requires availability of well written charts and is difficult to remember. (Figure 3)




Relative percentage of body surface area (% BSA) affected by growth

| | Age | | | | |
|---|---|---|---|---|---|
| **Body Part** | **0 yr** | **1 yr** | **5 yr** | **10 yr** | **15 yr** |
| a = 1/2 of head | 9 1/2 | 8 1/2 | 6 1/2 | 5 1/2 | 4 1/2 |
| b = 1/2 of 1 thigh | 2 3/4 | 3 1/4 | 4 | 4 1/4 | 4 1/2 |
| c = 1/2 of 1 lower leg | 2 1/2 | 2 1/2 | 2 3/4 | 3 | 3 1/4 |

**Figure-2 Lund & Browder chart**

One closed hand of an individual is equal to his 1% body surface area. This hand must be of the person concerned who sustains burns. A hand consists of all the fingers and thumb brought together in extended position, which include palm and all the fingers. This is applicable universally in every age group. This is popularly known as the ôRule of Palmô (Figure 4)

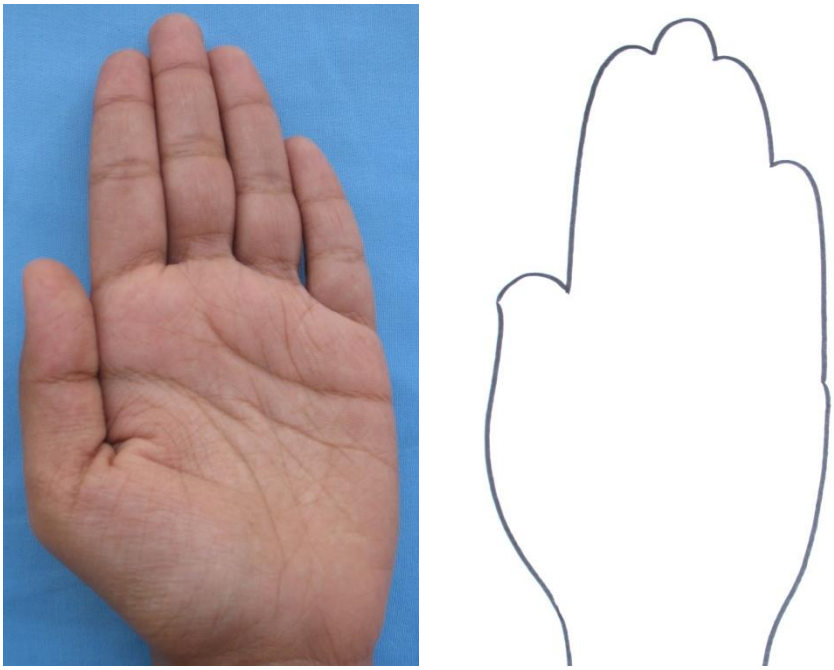


**Figure-3 Rule of Palm (1%)**

*UNDERSTANDING THE DEPTH OF BURN*

***First degree burn*** is epidermal burn alone which normally present as erythema/redness only. Typical example is sunburn. Burns due to any other cause is rarely a true first degree burn. They are very painful. There is no blister formation. It resolves in 3-5 days without scarring.

***Second degree burn*** involves epidermis and a portion of dermis but not the complete dermis. This is further divided into superficial or deep.

**Second degree superficial** is associated with involvement of epidermis & papillary dermis. It is characterized by severe pain, hyperaesthesia and blister formation. It heals in 10-20 days with minimal scarring.

**Second degree deep** or deep dermal burn involves epidermis, papillary dermis & a part of reticular dermis. Wound is waxy white, soft & elastic. It heals in 3-5 weeks and usually causes hypertrophic scar. They are in danger of getting converted to full thickness due to infection or drying.

***Third degree burn*** is also known as full thickness burn which involves the full thickness of skin, whole epidermis and dermis. It appears as tough, dry, inelastic, translucent & parchment like eschar.

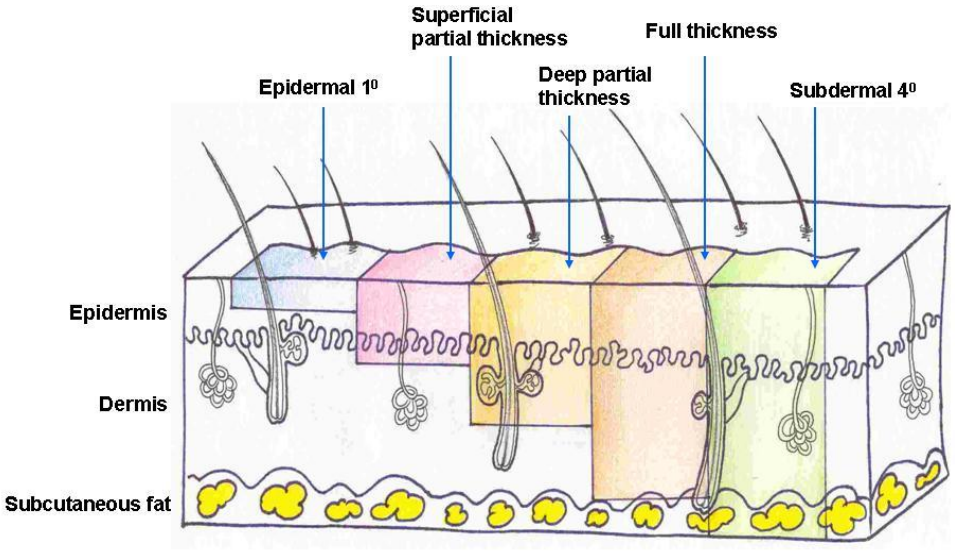



**Figure 4 – Histological presentation of Depth of burn**

Any involvement beyond dermis is normally included in full thickness burns but is sometimes described as ***fourth degree burn***. This involves subcutaneous tissues as well. Various depths of burn are well illustrated in figure 5.

*As we climb up the ladder from 1$^{st}$ degree to 4$^{th}$ degree, pain is remarkably decreasing as with more depth more nerve endings are destroyed.*

For the sake of convenience and practical utility burns are classified into two broad types:

1. Burns which heal on their own and do not require surgeonôs knife, called as ***partial thickness burns***.
2. Burns which do not heal on their own and require a surgeonôs help are known as ***full thickness burns***.

Partial thickness burns depending upon the amount of dermis involved are called ***superficial dermal /superficial partial thickness burns or deep dermal / deep partial thickness burns***.

**Diagnosing the depth**

Diagnosing different type of burns may not be easy.

**History:** History regarding **cause of burns** helps in diagnosing to some extent as in flame burns contact of fire is for a longer period of time; itôs likely to lead to full thickness burns.

Scalds from hot water spilling may be a superficial burn while a scald from falling into a hot water tub is likely to be deep because of prolonged contact. A scald from ghee, oil or any fat may likely to be deep because of high latent heat and viscosity of these substances.

Similarly chemical & electrical burns are almost always deep as compared to thermal burns of same extent; requiring intensive monitoring of vital parameters & more aggressive wound management.

Second history related fact is the age of the patient. At extremes of age (i.e. infants and older people), burns are likely to be deep because of thinness of skin ï atrophy of dermis and epidermis in old age and lesser formation of dermis and epidermis in children.

**Examination:**

Table 1: Physical appearance of Burns

| | Superficial | Deep |
|---|---|---|
| Appearance | Pink, soft | White, yellow or brown |
| Blanches on pressure | Yes | Fixed red or salt & pepper appearance |
| Hair follicles | Firmly fixed, provide resistance to pull | Pulled easily |
| Pain | Hyperalgesia to needle touch | Analgesia to needle touch. |

*Visible thrombosed capillaries, venules, or other blood vessels are sure sign of full thickness burn.*

Normally there is no difficulty in recognizing superficial partial thickness and full thickness burns but there is a lot of overlap in understanding deep partial thickness and full thickness burns.

Superficial partial thickness burns heal by the process of epidermal regeneration with minimum or reparative process. Thus, there is minimal or no scarring in these burns.

Deep partial thickness burns heal by reparative process with minimal amount of regenerative process involved. These burns heal with excessive fibrosis and result in hypertrophic scarring.

**Surgical importance of identification of depth of burns:**

Early estimation of depth of burns allows surgical intervention to be taken up at an appropriate time which ultimately reduces morbidity and mortality. Invariably, these partial thickness burns are treated with surgery. These burns are tangentially excised till the bleeding point or up to the viable reticular dermis; and the resulting raw area is skin grafted.

In full thickness burns, the entire area is excised either up to the subcutaneous plane or sometimes up to deep fascia and the resulting raw area is skin grafted. In this way, treatment modality of deep partial thickness and full thickness burns may appear to be similar.

JUDGING THE SEVERITY

Every burn patient looks normal and well oriented on arrival so much so that one may get confused and think of it as a simple injury.

*Any burn above 5% should be taken seriously.*

*All the burns above 10% in infants and children and all burns above 15% in adults are considered major burns and need hospitalization and fluid resuscitation.*

For the sake of convenience burns can be classified as:

Table 2: Burns classification based on severity

| | **Children** | | | **Adult** | |
|---|---|---|---|---|---|
| | Partial thickness | Full thickness | | Partial thickness | Full Thickness |
| Minor | <10% TBSA | --- | | <15%TBSA | <2%TBSA |
| Moderate | 10-15% TBSA | 1-3%TBSA | | 15-25%TBSA | 2-10%TBSA |
| Critical | >15%TBSA | >3%TBSA | | >25%TBSA | >10%TBSA |

***Minor burns*** (to be treated on out-patient basis)

- Burns less than 15% in adults and 10% in children (excluding chemical, electrical burns and burns of face, hands and perineum).

***Moderate burns***

- Require hospitalization for resuscitation and/or excisional therapy.
- Burns between 15-25% in adults.
- Full thickness burns between 3-10% in adults and 1-3% in children.

***Critical burns***

- Burns above 25% in adults, 15% in children and 5% in newborn and infants.
- Full thickness burns above 15% in adults and any extent in children.
- Electrical burns
- Chemical burns.
- Respiratory burns.
- Burns associated with other injuries.
    - Orthopaedic injury.
    - Chest injury.
    - Abdominal injury
    - Head injury.

***Escharotomy:***

In hospital, close watch should be kept for tight eschar bands on the chest and neck which increases the resistance of lungs. Escharotomy on the neck and chest should be done in all these cases removing any constriction & allowing lungs to expand.

Similarly tight eschar around limbs should be seen & compartment syndrome anticipated. Escharotomy on the limbs should be done either in central plane or mid-axial line. All these procedures should be undertaken in O.T in complete sterile conditions and after ensuring a patent i.v. line with adequate prior resuscitation.

***Inhalational Injury:***

History of burn in closed space points towards risk of inhalational injury. Patientôs respiratory status should also be assessed. Excessive oral secretions, pale/angry looking mucosa, singeing of nostril hairs and soot particles in oro-pharynx denote respiratory involvement. If it is associated with wheezing and brochospasm one must not hesitate to intubate these patients and give a bronchial lavage, if necessary. These patients should be put on positive pressure ventilation with PEEP if one finds signs of lung edema. If that is not available, patient should be put on T-piece and humidified oxygen. When intubation is not possible due to any reason one should perform tracheotomy.

## SUMMARY FOR NURSE & PARAMEDIC

- Burn is a 3 dimensional injury, assessed as Total Body Surface Area burns (TBSA).
- Rule of Nine is used for calculating the extent.
- Rule of Nine is not applicable in newborns, infants and children, where Lund & Browder chart is applicable.
- First degree burn is epidermal burn only ï doesnôt require treatment, heals with no scarring.
- $2^{nd}$ degree burn: $2^{nd}$ degree superficial burn heals in less than 2 weeks is painful.
- $2^{nd}$ degree deep dermal heals in 3 weeks & have less pain.
- $3^{rd}$ degree burn or full thickness burn doesnôt heal by itself. It requires skin replacement.
- $2^{nd}$ degree deep dermal and $3^{rd}$ degree burns are relatively painless.
- Thrombosed capillaries and blood vessels are signs of full thickness burns.
- All moderate and major burns require hospitalization and critical care.
- Escharotomy should be considered as a limb salvage procedure *only after* adequate resuscitation has been done.

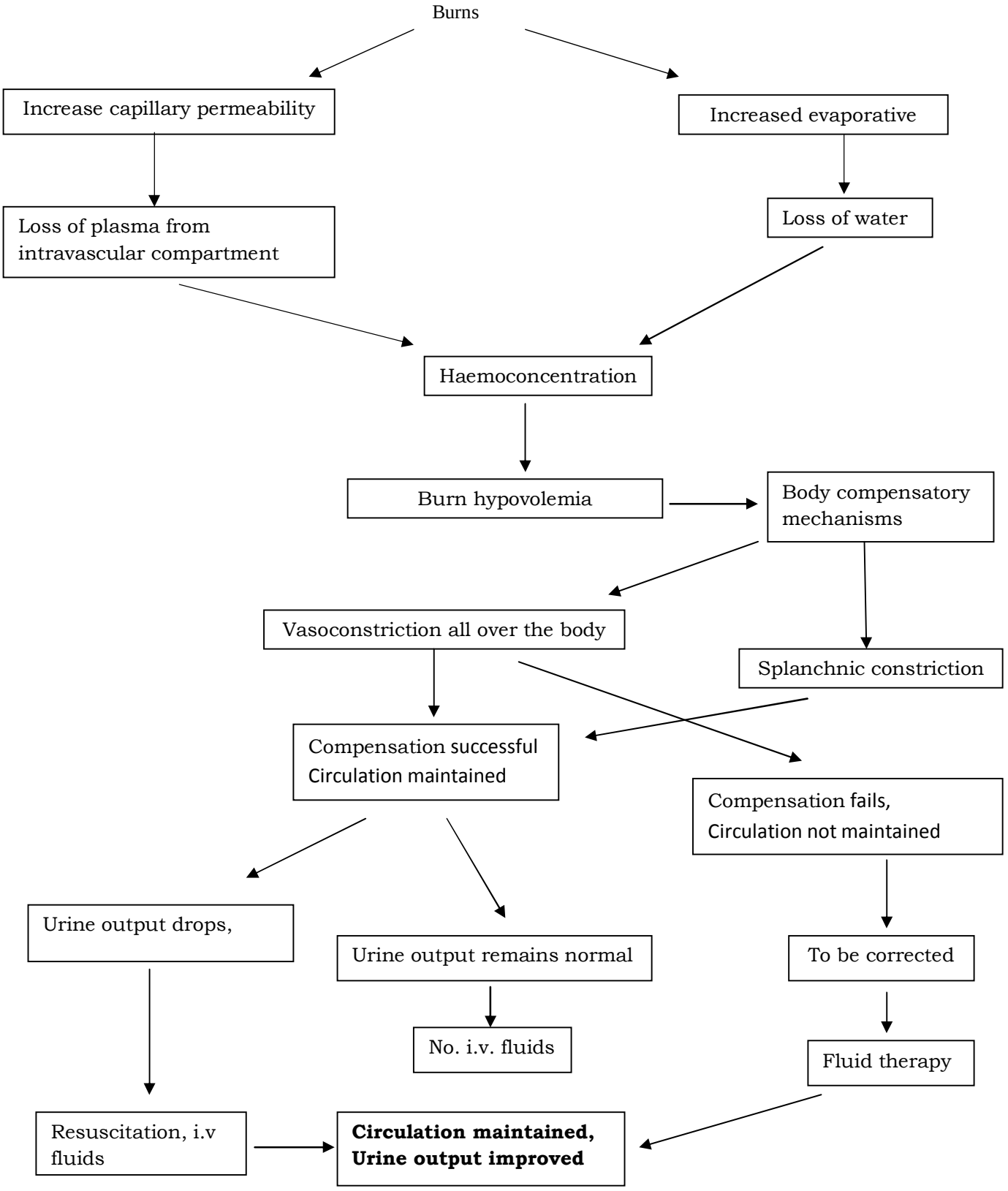
# 6. PATHOPHYSIOLOGY OF BURN SHOCK

A burn injury not only destroys the cutaneous barrier protecting the patient from a hostile environment, but it also leads to profound changes in almost all other organ systems. The deleterious effects of burn injury on the organ systems are proportional to the extent of burns.

Mechanism of thermal injury:

- **Agent**: Temperature & duration of exposure of the burning agent. There is an inverse relationship between these two parameters i.e.as temperature rises, a progressively shorter duration of exposure is required to inflict the same injury & vice versa.
- **Host**: Physical property of skin in the form of its thickness, water content, pigmentation, presence of hair, oil, dirt all influence severity of injury.
- **Environment**: Temperature and humidity also determine the severity of burn injury.

**Figure-6 Pathophysiology of Burns**



## Systemic manifestation of burn/body response to thermal injury

Burn Shock--Burns is a mechanism of heat transfer from high source to a low source. In non animated object it goes in a predictable manner with more energy transfer from source at higher temperature to source at lower temperature. However, this response is not so linear in living creature and humans; being modulated by different body responses through many different chemical mediators.

In addition to gross changes seen at local site of burns there are marked circulatory changes in the form of increased capillary permeability. This increased capillary permeability in major burns is not confined to the site of burns alone but to the *whole body.* Exact cause of this increased capillary permeability is not clearly understood. At times it is so great that colloidal substance of molecular weight as great as 15,000 daltons are ready to escape out from capillaries to the extra vascular space. This is seen maximum in the first 12 hours and then slowly phases out but still remains high *up to 24-36 hours*.

This increased capillary permeability creates a situation of hypovolemic shock which is seen in the form of:

- Increased pulse rate (Tachycardia)
- Dryness of mouth and skin (Dehydration)
- Cold clammy extremities (Hypothermia)
- Fall of blood pressure (Hypotension)
- Decreased urine output(Oliguria)

Initially body tries to compensate this by generalized vasoconstriction and constriction of splanchnic circulation to maintain cardiac output.

However, soon this compensatory mechanism fails if no attempt is made to correct the fluid loss. Further, loss of covering envelope of the body increases the evaporative losses which may be as much as 20 times that of normal.

Correction of this shock stage is essential and should be done as soon as possible. Main thrust remains to maintain intra vascular compartment, so that cardiac output can be brought to normal.

Initially it was thought that the patient loses plasma too, therefore patient should be infused with plasma along with primary resuscitation fluid. Britishers persisted with this theory and their main thrust of resuscitation remained plasma replacement. The Americans reasoned that because of increased capillary permeability in the first 24 hrs, whatever is given is likely to come out into the extra vascular space; therefore one must maintain intravascular compartment with crystalloid solution only.

Though the controversy of colloid and crystalloid is not fully resolved, it appears that ease of availability of crystalloid world over has made the use of crystalloid as a primary resuscitation fluid. Some of the important fluid resuscitation system along with fluid is given below-

Table-3 Parkland fluid resuscitation formula

| Duration | Formula | Colloid | Crystalloid | Maintenance |
|---|---|---|---|---|
| First 24 hours from time of burn | 4ML/KG/%BSA | NIL | RINGER LACTATE | NIL |
| Second 24 hours | 2ML/KG/%BSA | NIL | RINGER LACTATE | NIL |

- Fluid therapy is monitored by maintaining hourly urine output.

If Ringer lactate is not available, Normal saline may also be used for resuscitation. The role of soda bicarbonate is also reported in cases where metabolic acidosis occurs. Although Parkland formula is widely accepted, it has been associated with ñfluid creepò; which is accumulation of fluid in the extracellular & third space. Therefore, Parkland formula is modified in many burn centers in many ways for initial resuscitation. Thereafter, fluid requirement is titrated according to hourly urine output.

Best & least invasive method to see adequate perfusion is urine output. A urine output of 0.5ml-1ml/kg/hr denotes adequate perfusion. Thus, for an average person of 70kg, a urine output of 35ml/hour is regarded as adequate. For children, urine output of 1-2 (1.5)ml/kg/hr is considered optimal. Fluid loss is maximum in first 8 hrs, therefore half of calculated amount is infused in first 8 hrs and rest is infused in next 16 hours.

*Maintaining a good IV line is the lifeline of burns resuscitation*. Sometimes it may be difficult to put a peripheral line; in such cases, a long line in subclavian or external jugular vein should be introduced. A peripheral cut down which was routine done previously should be avoided as far as possible and should be performed as the last resort. Femoral lines either long or peripheral should be avoided for fear of DVT and its related complication.

All patients should be catheterized to monitor and see hourly urine output which is required for proper assessment and adequacy of fluid management. After 24 hrs the resuscitation fluid is nearly half of first 24 hrs.

It is recommended that before stopping resuscitative measure patient should start taking sufficient amount of fluids orally. This should be equal to the increased evaporative losses from the body *plus* normal daily requirements for the patient.

Initial oral fluid given should be small part of daily normal requirement and this should be slowly increased to normal daily requirement, including water loss from burn surface. Oral rehydration Solution (ORS) which is available in all hospitals for the treatment of diarrhoea, is also considered an optimum oral resuscitation fluid for burns. Its composition is as follows:

Table-4: Composition of ORS

| | |
|---|---|
| NaCl | 2.6gm(0.092oz) |
| Trisodium Citrate Dihydrate | 2.9gm(0.10oz) |
| KCl | 1.5gm(0.053oz) |
| Anhydrous Glucose | 13.5gm(0.48oz) |
| Above constituents are per Litre of Fluid. | |

Evaporative water loss can be calculated using a complicated nomogram using body surface area based upon height and weight.

## SUMMARY FOR NURSES & PARAMEDICS

- Following burns, there is massive Increase in capillary permeability causing rapid escape of fluid & electrolytes into extra vascular space.
- Primary treatment of burns *is fluid, fluid & fluid.*
- No role of colloid in first 24 hours, *Ringer lactate is the intravenous fluid of choice.*
- First & foremost importance in burns management is a *secure*

  wide bore i.v.line through which RL can be given rapidly.
- Parkland formula most widely accepted for calculating burn resuscitation fluid is

  4 X wt.(kg) X %TBSA burns.
- Hourly urine output is the most reliable indicator of adequate_resuscitation. Other parameters are pulse rate, hydration& blood pressure.
- Half of fluid calculated for first 24 hrs is given on $2^{nd}$ day which may be supplemented with colloids.
- Fluid to be given parenterally till patient starts taking orally adequately.
- Oral fluids should be encouraged after initial resuscitation.
- ORS is a good fluid for oral supplementation.

# 7. LOCAL WOUND MANAGEMENT

All burn areas are cleaned and loose dead skin is removed. Blisters are de-roofed, collected plasma removed and an appropriate dressing is applied. Biological dressing is preferred dressing material if available. Collagen is cheap and good skin substitute for partial thickness burns. If this is not available then a non-adhesive dressing in the form of paraffin gauze impregnated with 1% SSD, colloidal silver, ionic silver cream or silver nitrate cream is applied. Dressing is further supported with absorbent cotton pads (Gamgee). Dressing needs to be changed at regular intervals. Early change of dressing is advised if:

- Dressing becomes wet, smelly
- Becomes contaminated with urine or stool
- Patient shows any signs of infection like fever, vomiting, altered sensorium, distension of abdomen, decreased urine output-signs generally belong to septicemia or SIRS.
- Pain not explained by extent of burns.

These dressings should be opened and wound inspected to see for any local signs of wound infection.
Burn wound is a potential source of infection. Sepsis remains the main cause of mortality in burns. Routine prophylactic use of systemic antibiotics have been found to lead to development of resistant strains of bacteria and in long term failed to provide any reduction in sepsis related complication of burns. Use of topical antiseptic material reduces local growth of bacteria and reduces systemic septic complications.

Tetanus prophylaxis should be given as a rule in all burn patients.

Late in 60s, Fox made a compound which uses both silver nitrate and sulfonamide compound that is **Silver sulfadiazine**. This compound is stable; least absorbed systemically and does not lead to any systemic complications. Today, all over the world this is the most common topical agent used for burn wound dressings. Silver sulfadiazine (SSD) cream stood the test of time because of its broad spectrum range, ease of application, no side effects and extremely low systemic absorption properties.
But of late, bacterial resistance to SSD has emerged. Since superficial burns have shown satisfactory outcome even with other topical antibiotics, like Framycetin (Soframycin) & Neosporin, the use of SSD has to be judicious. It should be selectively used for deep dermal, full thickness, infected & old neglected burns.

**BIOLOGICAL DRESSINGS –**
These are the materials derived from human or animal tissues.

- For partial thickness or deep partial thickness burns:

- *Collagen dressings* are available in dry and wet forms. Collagen is good skin substitute especially in partial thickness burns and should be a dressing of choice.
- *Amniotic membrane* has been found to be very useful in our country however, because of fear of diseases caused by transmission of body fluids including HIV and AIDS these should be applied only when serological screening has confirmed negative report.
- In current scenario when all pregnant women are often subjected to serum marker testing beforehand, use of amniotic membrane is found to be safe & acceptable. Its use is also NOT dependent on the fact that childbirth is vaginal or via C-section.

- For full thickness burns:
  - All above mentioned products can be applied as a temporary cover for full thickness burns after excisional therapy has been done & skin grafting cannot be done because of limited or non availability of donor site.
  - Best dressing is *patient's own skin* graft (autograft). Therefore the role of excisional surgery & grafting is of great consequence in deep burns.
  - Sometimes when donor site is inadequate; especially in children, skin graft from parent/sibling (homograft) can be taken to provide temporary cover in order to reduce the septic load & promote the onset of anabolic phase of healing. But, homograft has to be always replaced with an autograft in due course of time.

**Excision surgery & skin grafting in burns**

- All full thickness burns require excision of dead skin. Douglas Jackson of Birmingham hospital of U.K. was probably amongst initial few people who suggested surgical intervention in burn patients. Zora Janzekovic of Yugoslavia was amongst the first who suggested the concept of tangential excision of burns which was initially implemented for deep dermal burns.

Gradually, same theory was extended for full thickness burn also and it was called as *sequential excision*.

- In case where burns are limited in size and site, these excision give an excellent result. Excision of localized full thickness burn up-to a living plane of subcutaneous tissue or deep fascia gives excellent result. As these areas are grafted quickly and wound closure is done fast, the patient recovery is quick.

- However these surgical procedures should not be taken as lightly in case of extensive burns. Excision of these cases should be done by expert only and should be done after complete resuscitation probably after $4^{th}$ day of burn trauma. Sufficient blood must be available before embarking on the surgery. For each 5% burn excision at least 1 unit of blood should be ready. Normally one should not attempt to excise more than 10% area at a time. Though extensive excision today are performed by experts where facilities are

excellent with cover by medical and anesthetic teams. In all cases the complete picture of bacterial colonization of wound should be assessed preoperatively and proper antibiotic should be given during surgery and 3 days after surgery. In full thickness burns it is better to perform direct excisional surgery rather than going for sequential surgery which may cause more blood loss.

- Blood loss in these patients must be quickly corrected because these patients have poor reserve.
- Raw area created must be covered with autograft. The autografts can be expanded by using different type of meshers, normally one should opt for expansion of 1:2 or 1:3.
- Meek Micro Graft- In this technique, grafts are cut into two planes dividing it into squares of 1-2 mm in size which are expanded on an adherent synthetic expandable sheet. Meek micro graft differs from mesh graft in that it looks like a postage stamp which expands on its lateral sides from all edges, while in case of mesh skin the central area heals by epithelialisation.
- Mesh graft is more popular than meek graft. Before embarking on excisional surgery, one should examine for donor area. In case of limited area, graft can be harvested from scalp, buttock, neck and sole area. Graft taken should be thin so that the next crop can be taken from the same area. Proper splintage should be given for proper immobilization.

**Skin substitutes**

- A variety of skin substitutes are available commercially. Different burn wounds are dressed with different synthetic bio-substitutes. These include transparent bio-adhesive presterilized sheets eg. Tegaderm or opsite. These are good materials for *partial thickness* burns as they control evaporative water loss to some extent.
- Secondly, improvements on these synthetic materials have been made which *partly incorporate and also help in formation of dermal bed.* These are usually applied on *full thickness* burns after excision on the resulting bed. These are Integra, Therafoam, Bio-brain, Omniderm, Trancyte etc.
- These materials are extremely good for application after excision of deep dermal or full thickness burns. However, their cost is exceptionally high. Hence, it has not been used routinely in our patients.

## SUMMARY FOR NURSES & PARAMEDICS

- All burn patients should be given tetanus prophylaxis.
- Burn wound should be cleaned well.
- Burn dressing is an integral part of burn management.
- Topical antibiotic creams like SSD, Soframycin, Neosporin should be used judiciously.

- Ideally burn dressings should be changed every day; sometimes earlier when they are soaked, contaminated or too tight causing pain.
- Biological dressings should be reserved for superficial burns especially in small children.
- Best dressing over burn wound is skin. All deep dermal wounds should be aimed for subsequent excision & grafting for definitive closure.
- For full thickness burns, sequential excision & grafting should be considered.
- All excision surgeries should be well planned. Patient should be adequately resuscitated, all parameters should be normal & blood should be arranged in addition to expert surgical & anaesthesia facilities.

# 8. INFECTION CONTROL IN BURN PATIENTS

***Role of prophylactic antibiotics:***

All the burn wounds are sterile up to 24 hrs so there is no need for antibiotic in first 24 hrs. Prophylactic use of antibiotics normally should be avoided as it has not been found to reduce chances of infection. All the procedures like catheterization, IV Line and Ryleôs tube should be done with no-touch technique.

Whenever a patient presents with Burns, his/her tetanus immunization status should be known. When this is not available, Injection tetanus toxoid & tetanus immunoglobulin should be given for passive immunity.

Hand-washing is a vital step in preventing burn infection. The caregivers should always wash hands before & after touching any Burn patient. Also the use of disposable sterile gloves before performing any intervention on the patient including dressings, cannulation etc. is always advocated.

Proper Hand-washing Technique

- A drop of liquid soap from dispenser should be taken on palm & both hands should be cleaned for minimum 30-60 seconds.
- Cleaning should be done over palm, dorsum, between fingers & thumb. Wrist should be cleaned as well.
- After seeing each patient, medical personnel should wash his hands or use chlorhexidine scrub.

***Antibiotic therapy:***

Units where patient are treated, must have their own antibiogram and sensitivity patterns whenever antibiotics are to be started fearing invasive sepsis.

Antibiotic should cover the entire bacterial flora found on patientôs wound surface. If that is not available, antibiotics are required to cover both gram ï ve and gram +ve bacterias. In some long standing cases fungal cover may also be required.

It is not uncommon to see the patients kept nil orally with $H_2$ blocker given intravenously. This process enhances the translocation of bacteria from gut and creates a situation of invasive sepsis.

## SUMMARY FOR NURSES & PARAMEDICS

- Infection control is of utmost importance in burns.
- All burn wounds are sterile initially therefore all aseptic precautions should be followed in order to prevent cross infection from caregivers.
- Early closure of burn wounds either by serial dressings or by excision & grafting is the definitive goal of treatment.

# 9. BURNS OF SPECIAL SITES

Some areas of body require special mention as management of burns in these areas is a different and formation of these area may completely devastate patientôs life.

## Burns of face

Face is the most important part of the body. Facial skin has got large papillary dermis with minimum amount of reticular dermis and is rich in vascularity. This area has tendency of rapid healing with quick deformation of face. Majority of burns of face are managed by exposure method & an expectant policy.

Cheeks, lips & forehead burns may undergo hypertrophic, atrophic & depigmented scarring following burns. However if timely seen, diagnosed and splinted much of deformation can be prevented. Areas to be watched are lips and nasolabial folds, where one should not hesitate to quickly shave of these areas and provide full thickness skin graft so that contracting bands are minimized. Proper face mask with lateral pull from circumoral area markedly reduces deformity in this area.

Practical tips: Open dressing, repeated cleaning, local antibiotic ointment application, early pressure garment, chin strap, face mask application.

## Burns of eyelid

Eyelid is an important structure which preserves the cornea and eye. If eyelid burns are full thickness in nature and these burns are a part of extensive burns to the rest of the body, one should be ready to perform tarsorraphy to preserve the cornea. Our experience shows that in case of extensive burns of other parts of body one often forgets about this area and ends up with exposed cornea and subsequent perforation.

The common post burn sequelae of the eyelids are ectropion, loss of eyelid and symblepheron; ectropion being the commonest. An eyelid ectropion can lead to exposure keratitis, corneal ulceration and ultimately loss of vision.

Till skin graft can be done over raw area, cornea is protected by ointment, pad and bandage. One should visit this area again when the patientôs condition improves. Skin graft is applied over the corrected defect. This delayed method saves both the patient and his eyes. Always overcorrection of the ectropion should be done preferably of one eyelid only.

Symblepheron occurs commonly after acid burns. In such cases one should evaluate whether the eye has vision or not. These cases have variable degrees of conjunctival loss which makes reconstruction very complicated.

## Ear burns

External ear has a special position and particularly prone to thermal injury. Lack of subcutaneous tissue & thin overlying skin closely adherent to cartilage further worsen the damage. Ear cartilages survive by plasmatic imbibitions from either side. Burn edema separates the skin from cartilage leading to devascularization of cartilage.

Some of the post burn injuries of ear are:

- Ear abscess
- Scarring of pinna
- Adhesion of ear to scalp
- Loss of helical rim
- Loss of upper or lower half of pinna
- Loss of entire pinna

In case of partial thickness burns, ear should be cleaned & all contours are filled up with acriflavine wool and soft adaptive firm dressing is applied. Whenever full thickness burns are present, it is excised along with dead cartilage and rest of the area is treated as a case of partial thickness burn.

Whenever abscess occurs it should promptly be drained with compression dressing. Whenever minor deformities occur, simple release & skin grafting can be done. Reconstruction of pinna is a multi-staged procedure and should be embarked upon only if surrounding skin & soft tissues are spared.

Prosthetic ears can also be used in long term wherever patient is not a candidate for surgery. Many patients may be satisfied by masking the defect with a change in hairstyle.

## Perineal burn

Perineal burns especially in children require special care. All these burns are treated by exposure methods. Patients are put in special bars so that abducted legs and thighs do not rub against scrotum or penis and buttocks are kept apart. All areas are cleaned and satisfactory position is maintained. SSD cream is used as topical agent. Usually stool and urine do not create much problem in wound healing. These areas rarely require skin grafting.

# 10. BURNS OF SPECIAL TYPES

## Electrical burns

In India incidence of electrical burns is rising at a high rate. In year 1993 electrical burns formed 3% of all admissions in burns unit. In the year 2000 it rose up to 12%.

Electrical burns are of two types- a) domestic type/low tension burn and (b)from transmission cables where current is greater than 1000 volts these are called high tension electric burns. Damage from electrical current is proportional to the current flow into the human body. More the voltage, more the current & more is the damage.

Current flows through the fluid medium that is through blood vessels and muscles. Nerves are supposed to be good conductors & they get burnt out immediately from high voltage of current. On the contrary, dry skin & bone are poor conductors. The severity of proximal tissue damage decreases as distance from the contact site increases.

It is commonly believed that damage from electrical current is progressive in nature and therefore any definitive surgery is not indicated in acute stage. The contrary view is that there is no progressive damage from electrical current. The late effects seen are because of the secondary effects from already damaged structures. Early intervention in electrical burns may prevent secondary damage. Therefore all electrical burns should be thoroughly examined about their cardiac status, neurological status and limb vascularity from direct damage due to the electrical current.

Cardiac arrhythmias and tetanic muscle spasms are more readily produced by alternating current. Alternating current is the mainstay of electricity in common households.

Majority of people die from muscle damage. Myoglobin released from damaged muscle is highly toxic and also a cardiac depressant. All these dead areas should be quickly excised and wherever possible, decompression should be performed by fasciotomy. Involved major vessel should be ligated proximal to the site of injury.

Development of compartment syndrome should also be recognized early. By decompression of fascia, further compression of venous system is avoided and further progress of damage is minimised.

Most patients with significant electrical injury have large fluid requirements. It is very important to give enough intravenous fluid to help maintain at least 2-5 ml/kg/hr of urine output. Higher output is necessary to clear the pigment from the circulation.

If myoglobin or free hemoglobin is present in urine, the urine output should be maintained at twice the desired volume. To prevent myoglobin precipitation in renal tubules, Sodium bicarbonate infusion at 12.5gm i.v. bolus followed by 12.5gm/hr i.v. until urine is clear of pigments.

Electrical burns are often associated with limb loss and amputations may also be required whenever indicated.

**Chemical burns**

Chemical burns amount to 0.3% of all burns unit admission. Acids as well as alkalis can cause chemical burns.

Acids lead to protein de-naturation of cell wall protein and this prevents further absorption reducing further risk of systemic damage. Alkalis come in contact with lipid moiety of cell wall protein leading to saponification and destruction of lysosomes with release of lysosomal enzymes causing cell damage. Therefore damage in case of alkali is perpetuating and may have late systemic effects.

Worst chemical burns are homicidal in nature where acid is thrown on face of the victim. These should be taken very seriously, eye should be washed thoroughly and tension in eyeball is reduced by giving Acetazolamide (Diamox). Thus perforation of cornea and loss of the eye is avoided. Whenever possible these burns should be primarily excised and grafted.

In case of chemical burns of any nature, one should rush to shower quickly to dilute the chemical and to wash it away with a jet of water if available.

*No attempt should be made to neutralize by antidote, as neutralization leads to further damage to structure from the heat generated from chemical reaction.*

**TAR BURNS**

Hot coal tar burns are seen quite commonly in labourers paving the roads. Tar has thermoplastic properties and it liquefies when heated. It becomes solid when applied to skin as the temperature cools. It is difficult to remove manually and may remove underlying viable skin.

Household materials like ghee and butter have been found to be useful for separating the tar from skin. Apart from them, Neosporin ointment when applied liberally helps in dissolving tar adherent to skin.

**BURNS IN PREGNANCY**

Women in the child bearing age group (18-45 years) constitute a substantial proportion of burned patients in our country. Thermal injury sustained during pregnancy presents special management problems. Prognosis of burns in pregnancy is poor & pregnancy may terminate spontaneously prior to death of the patient. A large majority of pregnant burned patients who survive can go on

to full term delivery. Several complications encountered in the management of pregnant burned patients which are detrimental to the foetus are:

- Hypotension & Hypovolemia
- Hypoxia
- Septicemia
- Dilutional hyponatremia
- Drug induced problems

Pregnancy must be confirmed. Ultrasound is the most widely accepted modality to monitor fetal parameters during pregnancy.

Measuring urine output is again the single most essential parameter to judge adequacy of resuscitation. Because of the physiological anemia of pregnancy, the normal hemoglobin values are 11-12g /dl, the need for blood transfusion is also decided by taking these parameters into consideration.

In first trimester of gestation, fetal death rate is high and it does not appear to be directly related to the extent of burns. Fetal survival is better in the second trimester. In the third trimester, it is the gestational age which is the important determining factor in fetal survival.

Healed burn scars on abdomen are of no consequence in a subsequent pregnancy. Abdominal enlargement in pregnancy is very gradual and the scars also stretch under the influence of maternal hormones.

**Breast burns:**

Burns of breast in childhood may cause scars which may compress, distort or displace the breast tissue. This may require surgical release & correction. Such breasts may get engorged and lead to discomfort following delivery. There is no technique which can restore lactation in such breasts.

# 11. Nutrition in Burns

Aggressive nutritional support is recommended following burn injury. All patients with burns should start oral feeds as soon as possible after initial. Oral fluids given should be $1/4^{th}$ of daily normal requirement and this should be slowly increased to normal daily requirement which should include extra water loss from burn surface.

All burn patients after 24-48 hrs should start on oral hyper-alimentation. Many formulae are available for protein and caloric requirement of the patients.

**Table-5 Curreri formulae for calorie & protein requirement in burns**

| | Calorie | Protein |
|---|---|---|
| Adult | 20Kcal X Body wt.(kg) +70 Kcal X % TBSA burns | 1gm X body wt.(kg) + 3 gm X %TBSA burns |
| Children | 60Kcal X Body wt.(kg) +35 Kcal X % TBSA burns | 3gm X body wt.(kg) + 1 gm X %TBSA burns |

This high requirement is difficult to maintain orally, therefore in initial phase balanced diet of high protein and high calories is given intravenously to supplement oral intake.

Protein should form 25% of energy requirement of burn patients. Glucose reduces the extent of hypermetabolic response and protein breakdown. Hence carbohydrate should form major part of the diet. It is recommended to give 50% of energy requirement as carbohydrate. Adults may be given 5 mg/kg/min and children 5-7 mg/kg/min. One of the recommendation is to give very little fat. In adults 4% and in children 2-3% of total energy requirement should be met with fat.

Each unit must be able to prepare diet formula depending upon local feeding habits. These formulae should be designed in consultation with a dietician. Whenever diet is prepared, one must see the proportion of carbohydrate and protein. One should see that the proteins are properly assimilated and they are used as building blocks not as a source of energy provider. Minimum of 100 calories are required for assimilation of 1 gm of nitrogen.

Patient should be regularly weighed and patient must not be allowed to lose weight for more than 5%. If patient loses 20% of its original weight, the outcome of such patient is unfavourable. Attention should be given to timely measurement of serum albumin and electrolytes. These parameters should be kept to near normal level. Burns patients tend to develop low immunity both humoral and cellular, therefore immuno-modulators are given to these patients. A good protein diet containing Glutamine, Arginine and other micronutrients like vitamins, iron,

calcium, zinc, selenium, copper & intravenous immunoglobulins especially IgG & IgM given to burn patients has shown to improve their survival. Early we are able to close burn wounds, the rapid is the recovery of immune and other systemic problems.

## SUMMARY FOR NURSES & PARAMEDICS

- Apart from IV fluids, oral resuscitation should be started in form of early enteral feeds wherever permissible, to prevent endotoxemia.
- Patients taking orally should be provided with adequate calories & proteins as per their increased requirements due to burns.
- Feeding regime should be individualized for the patient.

# 12. PREVENTION OF DEFORMITIES & CONTRACTURES

Following are the causes of post burn deformities and contractures:

1. Loss of organ or tissue due to very deep burn.
2. Loss of special organs like nose, ear, eye, eyelids, hands, feet, external genitalia etc.
3. Limbs are amputated due to vascular compromise, more common in electrical burn.
4. Delay in resurfacing of the raw area.
5. Use of very thin split skin graft.
6. Lack of use of Postoperative pressure garment and appropriate splints.
7. Recurrent ulceration in the area of burn.
8. Lack of physiotherapy and occupational therapy.
9. Involvement of the muscles, tendons and joints.

Prevention of deformities and contracture is an integral part of burn management. All burn patients receive active physiotherapy of all major joints and these joints should be kept in optimum positioning of function i.e. neck should be placed in slight extension without lateral rotation and in alignment with the thorax; axilla should be kept at 90 degree abduction, shoulder in 10 degree flexion and neutral rotation; elbow should be kept in extension and mid prone position, wrist at dorsiflexion, MCP AT 90 degree flexion, IP joint at neutral and thumb at abducted extended and opposed position.

The moment all areas are healed, they should be lubricated and proper physiotherapy and splintage given to avoid contracture formation. Compression garment and silicone gel sheet are provided to avoid scar hypertrophy and contracture formation resulting in deformity of limb and joint.

**Prevention of complication and rehabilitation of burn victims**

Majority of complications of burn areas arise due to the inability to foresee the problems at early stages. Majority of contractures can be prevented if they are given splintage and physiotherapy. Gross deformation of hands and knees are because of not using splints. These contractures would require surgical correction in order to restore optimum position. Use of compression garment helps in reducing hypertrophy.They increase local oxygen demand and thus prevent itching and hypertrophy.

## Prevention of hypertrophy and itching

Exact cause of hypertrophy and itching is not well known. However, it is found that it is because of the histamine release and increased oxygen demand. Frequent massage of burn scar with a non scented lubricant like coconut oil, often helps in preventing hypertrophy. Use of compression garment and sometimes excision and grafting followed by compression therapy helps in reducing hypertrophy and itching. Topical application of silicone gel or silicone gel sheet is helpful. Local injection of Triamcinolone helps in quick resolution of hypertrophy.

## SUMMARY FOR NURSES & PARAMEDICS

1. Recognise the causes of secondary deformities.
2. Prevent the deformities by appropriate postoperative management.
3. Postoperatively lubrication, massage and pressure garments are essential to prevent or minimise the deformities.
4. Appropriate surgical management of the post burn sequelae is possible.
5. Similar rehabilitation regime is followed after surgery for post burn deformities.

# 13. MANAGEMENT OF BURN DEFORMITIES

When primary management of burn is compromised, there is very high risk of development of deformities. Following deformities may occur as sequelae to burn:

1) Post burn unsightly, hypopigmented, hyperpigmented and hypertrophic scars.
2) Post burn contractures.
3) Fixed flexion deformities.
4) Loss of limb and organs.
5) Heterotrophic ossification.
6) Facial deformities.
7) Hand and feet deformities.
8) Post burn alopecia and
9) Many more.

Of all these deformities, the commonest is the hand deformities and thereafter face & neck. Once the deformities develop, they need to be managed timely and appropriately. Many factors are considered for management of the deformities. Age, sex, occupation, area of deformity, duration since wound healing etc decide the time and type of surgical management. Most of these deformities are disabling for the patient as well as matter of great concern for all the family members. Hence these should be managed on priority basis as and when it is fit for surgical intervention.

For loss of the organs appropriate reconstruction can be carried out. Most of the deformities are correctable to a large extent. But the burn scar is difficult to get rid of. One needs to discuss with the patient and his/her family members while managing the secondary deformities based on their choice as well as on the technical priorities. For example if severe contracture of neck is associated with contracture of axilla, technically the neck contracture gets priority even if patient wants correction of axillary deformity for the anaesthetic safety of the patient.

Along with surgical management of the deformity burn care givers should assess the psycho-social problems of the patient and appropriate treatment and psychological support should be provided.

## SUMMARY FOR NURSES & PARAMEDICS

1. There are many causes for occurrence of post burn defect and deformities.
2. Some of the deformities are preventable with appropriate post burn care.
3. Timely reconstruction of lost organ is desired.
4. Post burn deformities can be surgically managed by judicious surgical treatment.
5. One should remember that once scar is always a scar. We can minimize the burn scar but it may not be possible to remove it completely.

# 14. TEN COMMANDMENTS OF BURN MANAGEMENT

Acute burn care requires meticulous planning and attention to details. Often, small things escape attention and result in avoidable mortality and morbidity. Care of burn victim can be significantly improved if certain principles are adhered to. It has been proposed as "The Ten Commandments" of burn care. It is believed that these commandments will help and guide the young surgeon treating burns in far and remote corners of this vast continent.

**Ten commandments are:**

1. Maintain circulation and blood pressure (shock management)
2. Maintain airway
3. Increase body resistance
4. Avoid bacterial toxemia
5. Avoid auto-toxemia
6. Watch for renal complications and multiple organ dysfunctions
7. Maintain nutrition
8. Abide by principles of biomechanical physiotherapy and rehabilitation
9. Attend to psychological, emotional aspects and counseling
10. Analyze factors for reducing mortality.

Adherence to these principles and commandments can help us decrease the morbidity and mortality in this unfortunate set of patients. These commandments have been dealt with in details in earlier chapter as well as in a publication. (Ref: Gupta JL. Ten Commandments in Burn Management. Indian J Burns 2012;20:7-10)

# 15. A BRIEF PRACTICAL GUIDE TO MANAGEMENT OF BURN PATIENT

**ON SITE MANAGEMENT**

1. If patientôs clothes are on flames ï ask him to stop, lie on the ground and roll to douse the flames or rescuer douses the flames with water or by wrapping with a blanket and removing the blanket as soon as the flames are put off.
2. Rescuer to check for ABC (airway, breathing and circulation) and deliver CPR accordingly.
3. Burned body part to be put under running water or immersed in a bucket of water for 10-15 minutes or till burning pain subsides. Do not immerse whole body in water. Do not use ice or ice cold water.
4. Cover with a clean cloth and shift to nearest medical centre.
5. Do not apply any local agent on the wounds.
6. If patient has extensive burns and is conscious, may be given sugar and salt solution orally.
7. In case of electric burns ï switch off the main electric supply.
8. In case of chemical burns ï wash the affected area with running water continuously for 20 min and then shift to hospital.

**MANAGEMENT IN BURNS CASUALTY**

1. As soon as patient arrives, asses for ABC and CPR to be given accordingly.
2. Remove all clothes and assess patient for extent and depth of burn as per ñRule of nineò or Lund and Browder chart.
3. Weigh the patient.
4. Start wide bore I/V lines for infusing ringer lactate.
5. Remove all constricting objects like rings bangles etc.
6. Eschorotomy or fasciotomy to be done in circumferential burns.
7. Oxygen inhalation to be started if evidence of inhalation injury.
8. Dress the wounds with SSD or dressing material available.
9. Give Tetanus prophylaxis, preferably tetanus globulin.
10. Admit all major burns in the ICU.
11. Minor burns to be discharged with prescription of oral pain-killers and fluid intake and instructions for early return and follow up visits.
12. Maintain the records in detail.
13. Police information to be sent.
14. Medico legal formalities to be completed.

## MANAGEMENT IN ICU

1. I/ V fluids to be calculated and infused as per formula.
2. Monitor applied to measure vitals.
3. Assess airway for inhalation injury and intubate if required or give moist oxygen inhalation.
4. Catheterize the patient for monitoring urine output and aim at output of 0.5 ï 1 ml /kg / hr in adults and 1 ï 1.5 ml/kg /hr.
5. Assess extremities, neck and chest for circulation in case of circumferential full thickness thermal burns or electrical contact burns. To give escharotomy/ fasciotomy incisions as per requirements to improve circulation or respiration.
6. Arterial blood gas to be recorded in inhalation injury.
7. Nil orally till patient is out of shock, and then the patient can start oral sips only. Iincrease fluid and start semisolid diet after 24 to 48 hours once patient recovers from hypovolemic shock phase.
8. ECG monitoring for electric burns patient is essential.
9. If peripheral line not adequate put in a central line for fast fluid infusion and CVP monitoring.
10. Chest physiotherapy and extremity positioning and physiotherapy should be started from second day onwards.
11. Hemoglobin, hematocrit , Serum electrolytes , KFT and Blood sugar should be done daily or as per requirement.
12. I/ V fluids to be continued as per daily losses and requirements.
13. Monitor intake output chart.
14. Dressing to be done with 1 % SSD, collagen or silver dressings depending on availability and changed every 3 -5 days as per indication.
15. Tangential excision should be performed within 3 to 5 days for deep dermal burns or to continue conservative management if extensive burns.
16. Shift to HDU or step down ICU once patientôs general condition and oral intake improve.
17. No antibiotics are needed during initial period.
18. Systemic antibiotic to be given based on symptoms, wound and blood culture sensitivity and ward antibiogram.
19. Oral or parenteral analgesics and sedation for pain management are prescribed as per requirement.

## MANAGEMENT IN HDU AND WARD

1. Oral intake to be increased with high calorie and high protein diet. I/ V fluids to be supplemented as per intake / output chart.
2. Parenteral nutrition to be given based on oral intake.

3. Blood transfusion to be given as and when indicated.
4. Monitor blood investigations every 3rd day ï haemogram, electrolytes, KFT, Blood sugar and serum proteins .
5. Dressings to be changed every 3rd to 5th day or earlier if needed after a shower.
6. Active physiotherapy for limbs to continue.
7. Once slough separates and raw area is healthy, to be taken up for split thickness skin grafting.
8. Once all wounds covered and patient mobile, may be discharged and called for follow up in OPD.

**MANAGEMENT IN FOLLOW UP OPD**

1. Dressings to be done as required.
2. Once all wounds have healed ï advice for massage with oil or moisturiser, active physiotherapy, cervical collar, splints and pressure garments.
3. Check for compliance at regular intervals.
4. Counseling to be done.
5. Psychological support and rehabilitation.
6. Secondary surgery for correction of deformities after six months or as per indication.

# 16. SUGGESTED BOOKS FOR READING


1. Herndon D. Total Burn Care ; 4th Edition. Saunders 2009.
2. McCauley RL. Functional and aesthetic reconstruction of burned patients; Taylor and Francis Publishers 2005.
3. Kumar P. Fundamentals of Burn Management. 2nd Edition 2009.
4. Principles and practice of burn care. Sarabahi S, Tiwari VK, Goel A, Gupta LC (eds). Jaypee Brothers Medical Publishers (P) Ltd. New Delhi. 2010.
5. Salisbury RE. Thermal burns. In: McCarthy JM, ed: Plastic surgery. Philadelphia,
6. Paediatric Burns: Total Management of the Burned Child. Ed: Marella L. Hanumadass, K. Mathangi Ramakrishnan. New Delhi, Paras Medical Publisher,2011

# 17. APPENDIX

## 17 a. APPENDIX
## Blood Hematology - Normal Values
## Measure (abbreviations, synonyms) Typical Normal Range
## Whole Blood

| | |
|---|---|
| Hematocrit (HCT; packed cell volume) | 38-54% (men) |
| | 36-47% (women) |
| Hemoglobin (Hb) é .. é é é . | 14-18 g/dL (men) |
| | 12-16 g/dL (women) |
| | 12-14 g/dL (children) |
| | 14.5-24.5 g/dL (newborns) |
| Complete Blood Count (CBC) per mm | 3 percentage |
| Erythrocytes (Red blood cells; RBCs) | 4.5-6 x104 (men) |
| | 4.3-5.5x104 (women) |
| Reticulocytes é .. é é é . | 0-1% of RBCs |
| Leukocytes (total) | 5000-10000 |
| Myelocytes | 0 0% of leukocytes |
| Juvenile neutrophils | 0-100 (0-1%) |
| Band neutrophils | 0-500 (0-5%) |
| Segmented neutrophils | 2500-6000 40-60%) |
| Lymphocytes | 1000-4000 20-40%) |
| Eosinophils | 50-300 (0-5%) |
| Basophils | 0-100 (0-1%) |
| Monocytes | 200-800 (4-8%) |
| Platelets é .. é é é . | 200,000-500,000 |

RBC Measurements

| | |
|---|---|
| Diameter | 5.5-8.8 µm |
| Mean corpuscular volume (MCV) | 80-94 µm3 |
| Mean corpuscular hemoglobin (MCH) | 27-32 pg |
| Mean corpuscular hemoglobin concentration | 33.4-35.5 g/dL |

Miscellaneous

| | |
|---|---|
| Prothrombin time (PT) | 10-20 seconds 0.8-1.2 INR |
| (International Normalized Ratio) | |
| Activated Partial Thromboplastin Time (aPTT) | 30-45 seconds |

Notes: The normal ranges in each laboratory depend on the local population, test methodology and conditions of assay, units, and a variety of other circumstances. The ranges above are typical, but the normal values established for each laboratory should be used for most purposes. Normal ranges for newborns often vary from the adult ranges.

## 17 b. APPENDIX

### Blood Serum Chemistry - Normal Values

| | | |
|---|---|---|
| **Electrolytes** | | |
| | Bicarbonate (total) | 18-30 mEq/L |
| | Calcium (total) | 9-11 mg/dL; 4.5-5.5 mEq/L |
| | Chloride | 98-106 mEq/L |
| | Magnesium | 1.8-3.6 mg/dL; 1.5-3.0 mEq/L |
| | Phosphorus | 3-4.5 mg/dL; 1.8-2.3 mEq/L (adults) |
| | | 4-6.5 mg/dL; 2.3-3.8 mEq/L (children) |
| | Potassium | 3.5-5.5 mEq/L |
| | Sodium | 135-147 mEq/L |
| **Enzymes*** | | |
| | Alkaline Phosphatase | 50-160 U/L |
| | Amylase | 53-123 U/L |
| | Creatine Kinase (CK, CPK) | 38-174 U/L (males) |
| | | 96-140 U/L (females) |
| | Lipase | 10-150 U/L |
| | ALT (GPT) | 0-30 U/L |
| | AST (GOT) | 0-40 U/L |
| **Others** | | |
| | Albumin | 3.5-5.5 g/dL |
| | Bilirubin | <1.0 mg/dL total |
| | | <0.4 mg/dL direct (glucuronide- or sulfate-conjugated) |
| | Cholesterol | <225 mg/dL (depends on age) |
| | Creatinine | 1.0-2.0 mg/dL |
| | Globulin | 1.5-3.5 g/dL |
| | Glucose | 80-120 mg/dL |
| | Protein (Total) | 6.3-8.0 g/dL |
| | Triglycerides | 40-200 mg/dL |
| | Urea | 20-40 mg/dL |
| | Uric Acid | 2.0-4.0 mg/dL |

Notes: The normal ranges in each laboratory depend on the local population, test methodology and conditions of assay, units, and a variety of additional circumstances. * The units for enzyme activities are especially sensitive to such circumstances. The normal ranges above are typical, but the normal ranges established for each laboratory should be used for most purposes. The units g/dL (grams per deciliter) and mg/dL are sometimes expressed as g% and mg%, or g/100 mL and mg/100 mL.

# 17 c. APPENDIX

Nutritive value of common food items Fruits

| S.No. | Foodstuff | Energy | Protein | Carbohydrate | Fat | Fibre | Calcium | Iron |
|---|---|---|---|---|---|---|---|---|
| | Apple | 59 | 0.2 | 13.4 | 0.5 | 0.3 | 10 | 0.66 |
| | Banana | 116 | 1.2 | 27.2 | 0.3 | 0.4 | 17 | 0.36 |
| | Dates, Fresh | 144 | 1.2 | 33.8 | 0.4 | 3.7 | 22 | 0.96 |
| | Grapefruit | 45 | 1 | 10 | 0.1 | | 30 | 0.2 |
| | Grapes | 71 | 0.5 | 16.5 | 0.3 | 2.9 | 20 | 0.52 |
| | Guava | 51 | 0.9 | 11.2 | 0.3 | 5.2 | 10 | 0.27 |
| | Jackfruit | 88 | 1.9 | 19.8 | 0.1 | 1.1 | 20 | 0.56 |
| | Lemon | 57 | 1 | 11.1 | 0.9 | 1.7 | 70 | 0.26 |
| | Litchi | 61 | 1.1 | 13.6 | 0.2 | 0.5 | 10 | 0.7 |
| | Lime, Sweet, Mosumbi | 43 | 0.8 | 9.3 | 0.3 | 0.5 | 40 | 0.7 |
| | Mango | 74 | 0.6 | 16.9 | 0.4 | 0.7 | 14 | 1.3 |
| | Musk Melon | 17 | 0.3 | 3.5 | 0.2 | 0.4 | 32 | 1.4 |
| | Orange | 48 | 0.7 | 10.9 | 0.2 | 0.3 | 26 | 0.32 |
| | Papaya | 32 | 0.6 | 7.2 | 0.1 | 0.8 | 17 | 0.5 |
| | Pears | 52 | 0.6 | 11.9 | 0.2 | 1 | 8 | 0.5 |
| | Pineapple | 46 | 0.4 | 10.8 | 0.1 | 0.5 | 20 | 2.42 |
| | Sapota (Chikoo) | 98 | 0.7 | 21.4 | 1.1 | 2.6 | 28 | 1.25 |
| | Water Melon | 16 | 0.2 | 3.3 | 0.2 | 0.2 | 11 | 7.9 |
| | **GRAINS** | | | | | | | |
| | Maize | 342 | 11.1 | 66.2 | 3.6 | 2.7 | 10 | 2.3 |
| | Oatmeal | 374 | 13.6 | 62.8 | 7.6 | 3.5 | 50 | 3.8 |
| | Rice (Raw) | 345 | 6.8 | 78.2 | 0.5 | 0.2 | 10 | 0.7 |
| | Rice(Par-Boiled) | 346 | 6.4 | 79 | 0.4 | 0.2 | 9 | 1 |
| | Wheat (Whole) | 346 | 11.8 | 71.2 | 1.5 | 1.2 | 41 | 5.3 |
| | Wheat Flour (Whole) | 341 | 12.1 | 69.4 | 1.7 | 1.9 | 48 | 4.9 |
| | **PULSES** | | | | | | | |
| | Bengal gram (dal) | 372 | 20.8 | 59.8 | 5.6 | 1.2 | 56 | 5.3 |
| | Kesari Dal | 345 | 28.2 | 56.6 | 0.6 | 2.3 | 90 | 6.3 |
| | Lentils | 343 | 25.1 | 59 | 0.7 | 0.7 | 69 | 7.58 |
| | Peas (Dry) | 315 | 19.7 | 56.5 | 1.1 | 4.5 | 75 | 7.05 |
| | Rajmah | 346 | 22.9 | 60.6 | 1.3 | 4.8 | 260 | 5.1 |
| | Red gram (Dal) | 335 | 22.3 | 57.6 | 1.7 | 1.5 | 73 | 2.7 |
| | Soyabean | 432 | 43.2 | 20.9 | 19.5 | 3.7 | 240 | 10.4 |
| | **SPICES** | | | | | | | |
| | Cardamon | 229 | 10.2 | 42.1 | 2.2 | 20.1 | 130 | 4.6 |
| | Chillies, Dry | 246 | 15.9 | 31.6 | 6.2 | 30.2 | 160 | 2.3 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Cloves, Dry | 286 | 5.2 | 46 | 8.9 | 9.5 | 740 | 11.7 |
| | Coriander Seeds | 288 | 14.1 | 21.6 | 16.1 | 32.6 | 630 | 7.1 |
| | Cumin Seeds | 356 | 18.7 | 36.6 | 15 | 12.1 | 1080 | 11.7 |
| | Garlic, Dry | 145 | 6.3 | 29.8 | 0.1 | 0.8 | 30 | 1.2 |
| | Ginger, Fresh | 67 | 2.3 | 12.3 | 0.9 | 2.4 | 20 | 3.5 |
| | Peper, Dry | 304 | 11.5 | 49.2 | 6.8 | 14.9 | 460 | 12.4 |
| | Turmeric | 349 | 6.3 | 69.4 | 5.1 | 2.6 | 150 | 67.8 |
| | **OILS AND FATS** | | | | | | | |
| | Butter | 729 | | | 81 | | | |
| | Cooking Oils (Gingelly) Groundnut, Mustard, Coconut | 900 | | | 100 | | | |
| | Ghee (Buffalo) | 900 | | | 100 | | | |
| | Hydrogenated fat (fortified) | 900 | | | 100 | | | |
| | **LEAFY VEGETABLES** | | | | | | | |
| | Bathua | 30 | 3.7 | 2.9 | 0.4 | 0.8 | 150 | 4.2 |
| | Bengal gram leaves | 97 | 7 | 14.1 | 1.4 | 2 | 340 | 23.8 |
| | Cabbage | 27 | 1.8 | 4.6 | 0.1 | 1 | 39 | 0.8 |
| | Coriander Leaves | 44 | 33 | 6.3 | 0.6 | 1.2 | 184 | 1.42 |
| | Spinach | 26 | 2 | 2.9 | 0.7 | 0.6 | 73 | 1.14 |
| | **ROOT VEGETABLES** | | | | | | | |
| | Carrot | 48 | 0.9 | 10.6 | 0.2 | 1.2 | 80 | 1.03 |
| | Colacasia (Arbi) | 97 | 3 | 21.1 | 0.1 | 1 | 40 | 0.42 |
| | Onion | 59 | 1.8 | 12.6 | 0.1 | 0.6 | 40 | 1.2 |
| | Potato | 97 | 1.6 | 22.6 | 0.1 | 0.4 | 10 | 0.48 |
| | Raddish | 17 | 0.7 | 3.4 | 0.1 | 0.8 | 35 | 0.4 |
| | **OTHER VEGETABLES** | | | | | | | |
| | Bittergourd | 25 | 1.6 | 4.2 | 0.2 | 0.8 | 20 | 0.61 |
| | Bottlegourd | 12 | 0.2 | 2.5 | 0.1 | 0.6 | 20 | 0.46 |
| | Brinjal | 24 | 1.4 | 4 | 0.3 | 1.3 | 18 | 0.38 |
| | Capsicum | 24 | 1.3 | 4.3 | 0.3 | 1 | 10 | 0.56 |
| | Cauliflower | 30 | 2.6 | 4 | 0.4 | 1.2 | 33 | 1.23 |
| | Cucumber | 13 | 0.4 | 2.5 | 0.1 | 0.4 | 10 | 0.6 |
| | Drumsticks | 26 | 2.5 | 3.7 | 0.1 | 4.8 | 30 | 0.18 |
| | French Beans | 26 | 1.7 | 4.5 | 0.1 | 1.8 | 50 | 0.61 |
| | Jack Fruit, Tender | 51 | 2.6 | 9.4 | 0.3 | 2.8 | 30 | 1.7 |
| | Ladies Finger | 35 | 1.9 | 6.4 | 0.2 | 1.2 | 66 | 0.35 |
| | Lotus Stem (Dry) | 234 | 4.1 | 51.4 | 1.3 | 25 | 405 | 60.6 |
| | Peas | 93 | 7.2 | 15.9 | 0.1 | 4 | 20 | 1.5 |
| | Plaintain, Green | 64 | 1.4 | 14 | 0.2 | 0.7 | 10 | 6.27 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Pumpkin | 25 | 1.4 | 4.6 | 0.1 | 0.7 | 10 | 0.44 |
| | Tomato | 20 | 0.9 | 3.6 | 0.2 | 0.8 | 48 | 0.64 |
| | Water Chestnut (Fresh) | 115 | 4.7 | 23.3 | 0.3 | 0.6 | 20 | 1.35 |
| | **FISH, MEET AND POULTRY PRODUCTS** | | | | | | | |
| | Fowl | 109 | 25.9 | | 0.6 | | 25 | |
| | Goat Meat | 118 | 21.4 | | 3.6 | | 12 | |
| | Liver | 150 | 19.3 | 1.3 | 7.5 | | 10 | 6.3 |
| | Pork | 114 | 18.7 | | 4.4 | | 30 | 2.2 |
| | Egg | 173 | 13.3 | | 13.3 | | 60 | 2.1 |
| | Mutton | 194 | 18.5 | | 13.3 | | 150 | 2.5 |
| | Pomfret fish | 87 | 17 | 1.8 | 1.3 | | 200 | 0.9 |
| | Pork | 114 | 18.7 | | 4.4 | | 30 | 2.2 |
| | Buffalo's milk | 117 | 4.3 | 5 | 6.5 | | 210 | 0.2 |
| | Cheese (Processed) | 348 | 24.1 | 6.3 | 25.1 | | 790 | 2.1 |
| | Cow's milk | 67 | 3.2 | 4.4 | 4.1 | | 120 | 0.2 |
| | Curds | 60 | 3.1 | 3 | 4 | | 149 | 0.2 |
| | Khoa, Whole Buffalo Milk | 421 | 14.6 | 31.2 | | 650 | 5.8 | |
| | Milk, Cow's | 67 | 3.2 | 4.4 | 4.1 | | 120 | 0.2 |
| | Milk, Human | 65 | 1.1 | 7.4 | 3.4 | | 28 | |
| | Milk,Bufflalo's | 117 | 4.3 | 5 | 6.5 | | 210 | 0.2 |
| | Skimmed Milk | 29 | 2.5 | 4.6 | 0.1 | | 120 | 0.2 |
| | **OTHERS** | | | | | | | |
| | Biscuits, salted | 534 | 6.6 | 54.6 | 32.4 | | | |
| | Biscuits, sweet | 450 | 6.4 | 71.9 | 15.2 | | | |
| | Bread | 245 | 7.8 | 51.9 | 0.7 | | 11 | 1.1 |
| | Cane Sugar | 398 | 0.1 | 99.4 | 0 | | 12 | 0.15 |
| | Fish Liver Oil | 900 | | | 100 | | | |
| | Honey | 319 | 0.3 | 79.5 | 0 | | 5 | 0.69 |
| | Jaggery | 383 | 0.4 | 95 | 0.1 | 80 | 2.64 | 168 |