# MANAGEMENT OF BURNS WOUND COMPARATIVE ANALYSIS OPEN EXPOSURE METHOD VS CLOSED COLLAGEN METHOD

Dissertation submitted to

**THE TAMILNADU DR. M.G.R. MEDICAL UNIVERSITY**

*In partial fulfillment for the award of the degree of*

**MASTER OF SURGERY**

IN

GENERAL SURGERY


**DEPARTMENT OF GENERAL SURGERY**

**THANJAVUR MEDICAL COLLEGE**

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**APRIL- 2013**

## CERTIFICATE

This is to certify that this dissertation entitled **MANAGEMENT OF BURNS WOUND COMPARATIVE ANALYSIS OPEN EXPOSURE METHOD VS CLOSED COLLAGEN METHOD** is the bonafide original work of **Dr. S.MANIMARAN** in partial fulfillment of the requirements for M.S. Branch -I (General surgery) Examination of the Tamilnadu Dr. M.G.R. Medical University to be held in APRIL - 2013. The period of study is from 2010 to 2013.


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# DECLARATION

I, **Dr.S.MANIMARAN,** solemnly declare that the dissertation titled "**MANAGEMENT OF BURNS WOUND COMPARATIVE ANALYSIS OPEN EXPOSURE METHOD VS CLOSED COLLAGEN METHOD** is a bonafide work done by me at Thanjavur Medical College, Thanjavur during 2010-2013 under the guidance and supervision of **Prof. Dr.MARAGATHAMANI ELANGOVAN.M.S.,** Thanjavur Medical College, Thanjavur.

This dissertation is submitted to Tamilnadu Dr. M.G.R Medical University towards partial fulfillment of requirement for the award of

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Place: Thanjavur.

Date:. **(Dr.S.MANIMARAN)**

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## CERTIFICATE

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| Name of the candidate | : | **Dr. S.MANIMARAN** |
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The Ethical Committee, Thanjavur Medical College has decided to inform that your Dissertation Topic is accepted and you are permitted to proceed with the above study.

Thanjavur — Secretary

Date: — Ethical Committee

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**CONTENTS**

# INTRODUCTION

Ever since man discovered fire he also accidentally burnt himself. India has an ancient culture where the fire is worshipped traditionally. It is probably the potential fury of an unharnessed fire that made man bow before it.

Burns are among the oldest injuries that man still suffers from. The burn injury can be one of the most serious and devasting forms of trauma that man can sustain. A burn injury not only destroys the cutaneous barrier but it also leads to profound changes in almost all other organ systems so much so, burn injury has been considered to be the "Universal Trauma Model".

Millions of people around the world are hospitalized for the treatment of burns each year and thousands die. The daily cost of care for a burn victim is tremendous. The economic loss to any nation is staggering and must be measured not only in currency but in the permanent loss of millions of productive years. Painful and lengthy hospitalization, multiple stages of surgery, permanent disfigurement and disability, prolonged rehabilitation, loss of income and job and enormous financial burden are some of the horrors looming large over the burn victims.

The success or failure of treatment of burn victim is difficult to measure. Survival or death is not necessarily an adequate yardstick. Death of the victim with a nearly total body surface injury and so deep as to preclude full functional recovery may not be considered as failure. Similarly, survival without consideration of the functional and social rehabilitation of the victim should not be the only measure of success. The burn team must treat the patient as a whole person and measure success or failure not on how they understand and treat the burn but on how they understand, treat and rehabilitate the burned patient.

Burn would care is really a tough clinical problem which needs close monitoring and follow up. Here, in this study, a maiden attempt is made to treat the burn wound using collagen membrane as temporary cover and results are analyzed in comparison with conventional open method.

# AIM OF STUDY

The aim of the study is to compare and analyze the outcome of two methods of Burn Wound Care viz.

- Open Exposure method vs
- Closed collagen method (using collagen membrane as temporary cover)

The study and results are being analyzed in terms of

- Mortality differences
- Morbidity differences
    - Fluid and electrolytes loss
    - Pain relief
    - Wound infection
    - Wound healing and contraction
    - Duration of hospital stay

# METHODS AND MATERIALS

**Study period:**

This is a prospective clinical trial and the study period extends from 2010 to 2013.

Patient selection:

Of all the burns patients admitted to Thanjavur Medical College Hospital and Rajah Mirasudar Hospital, Thanjavur Medical College, Thanjavur, during the above said period 60 patients were selected based on the following selection criteria and these patients are subjected to this clinical trial.

- Patients aged 50 years or less than 50 years
- Patients having burns of less than 50% TBSA
- Patients having no or mild inhalation injury
- Patients who do not have any cardiopulmonary compromise
- Patients who reached the hospital before the end of 24 hours since injury.

Selected patients were divided into two groups (Group I and Group II) with each group having 30 patients. Each group contained 24 adult patients and 6 paediatric patients.

**Methods:**

At admission, all the patients in both groups were assessed for resuscitation. In this study we used the Parkland formula for fluid management. This calculates the fluid to be replaced in the first 24 hours by the following formula:

Total percentage of body surface area X weight in kilogramsX 4=volume in ml.

Half of this volume is given in the first 8 hours and the second half is given in the subsequent 16 hours. In children, maintenance fluid must also be given. This is normally dextrose – saline given as follows:

- 100ml per kg for the first 10 Kg.
- 50ml per kg for the next 10Kg:
- 20ml kg for 24 hours for each kilogram over 20kg body weight**.**

The methods used in this study for the early care of burns wound include

- Open Exposure method vs
- Closed collagen method-(using collagen as Temporary biological cover)

Patients in Group I were studied with open method of Burns Wound Care which included

- Wound cleansing and Debridement under IV sedation
- Application of Silversulphadiazine Cream topically
- Exposure of the patients without any dressing or temporary wound cover
- Follow up

Patients in Group II were treated and studied with closed or occlusive method of Burns wound care which included.

- Wound cleansing and debridement under IV ketamine
- Wound covered with collagen membrane which was thoroughly washed in sterile saline before application or dry collagen sheet.
- Follow up

The patients in both groups were treated by above mentioned methods during the resuscitation period (i.e. within 24 hours post burn) with resuscitation being continued.

All the patients were subjected to the following investigations, at admission and if needed during follow-up.

- Urine – Albumin/Sugar
- Blood – Urea/ Creatinin/Sugar/Electrolytes
- Haemoglobin and PCV
- Blood Grouping and Typing
- ECG & X-ray Chest

Each case was followed up by making entries in the proforma with detailed clinical observation during follow up in terms of

- Fluid and Electrolyte imbalance and resuscitation requirements
- Vital signs monitoring
- Urine output
- Pain relief
- Fluid requirement
- Feeding – Enteral / Parenteral
- Collagen separation

- Wound infection and Antibiotics
- Wound healing and contraction
- Need of Blood transfusion
- Skin grafting. Final results are analyzed in terms of mortality and morbidity differences.

- **MATERIAL: "COLLAGEN"**

It is an insoluble fibrous protein of vertebrates that is the chief constituent of the fibrils of connective tissue (as in skin and tendons) and the organic substance of bones and yields gelatin and glue on prolonged heating with water.Collagen is found in the extracellular marix.20 types of collagen have been described till recently.25 to 35%of body protein is collagen. Type I and Type III are more commonly seen in all the tissues.Commercially ,collagen is extracted from bovine source;sheep's intestine ,tendo-achilles of sheep and from the dermis.

**Structure of collagen**

Collagen molecule is a rigid rod 2900 $A^0$ by 15 $A^0$ size triple helix in structure with 3 amino acids GLY-X-Y sequence repeated and glycine with a single carbon atom is in every $3^{rd}$ residue and fits into the superhelix.It is stabilized by proline and hydroxyproline residues.

**Function of collagen**

Collagen has high content of diamino dicarboxylic amino acids and carbohydrate moieties,which makes it hydrophilic and very suitable for cell adhesion.Presence of glycoprotion like fibronectin promotes attraction of fibrogenic cells to collagen implants. Collagen gives strength and structure to the tissues ,support to the hard tissues like bone,form and integrity to soft tissues,provides stiff layer to vessel wall,thus preventing cellular growth.It has hemostatic properties.Collagen is commercially manufactured and is readily available for use .Dried collagen sheet and alcohol preserved varieties are available.

**Application of Collagen sheet**

The method of application of collagen sheet in the native form,from the bovine intestine is the same as it is for amniotic membrane.The wounds is cleansed with antiseptic solution and covered with the collagen sheet after rinsing the sheet several times in normal saline and is allowed to adhere over a period of few hours. Collagen sheets are useful in the management of superficial partial thickness burns,and in deep partial thickness wounds. collagen sheets are little thicker than the other membrane dressings and takes

more time to spread on the wound . Collagen has all the properties of an ideal substitute and is used freely on open wounds.

**Reconstituted collagen**

The collagen is solubilized and purified and then attempts are made to reform and repolymerize the material in proper shape,and thus the collagen is reconstituted in the form of a thin film. During the process of reformation and repolymerization,drugs can be incorporated and used for delivery to the wound surface .Both Human and Bovine collagen can be reconstituted .

## BIOLOGY AND PHYSIOLOGY OF SKIN

Skin consists of two distinct layers;

- Epidermis
- Dermis

These layers are integrated by a structure known as the basement membrane.

### Epidermis

The epidermis is the outer layer and act as the barrier between body tissues and the environment. This layer protects against infection, ultraviolet light, and evaporation of fluids and provides thermal regulation.Repair of epidermal wounds is achieved through regeneration of epidermal cells both from the perimeter of the wound and from the adnexal structures of the epidermis(i.e., hair follicles, sweat glands, and sebaceous glands). Accordingly, pure epidermal injuries heal without scarring.The principal cell of the epidermis is the keratinocyte. These cells are arranged into five progressively differentiated layer.

- Stratum basale
- Stratum spinosum

- Stratum granulosum
- Stratum lucidum
- Stratum corneum

The outermost of these layers-the relatively impermeable stratum corneum-provides the barrier mechanism that protects the underlying tissues.Besides keratinocytes,the epidermis contains cells from other embryologic layers that carry out specific functions .Melanocytes derived from fetal neuroectoderm,produce melanosomes which become pigmented as a result of the formation of melanin through the action of the enzyme tyrosinase.Langerhans cells,derived from bone marrow cells play a critical role in the immune function of skin.These cells recognize, Phagocytize,process ,and present foreign antigens and ,through their expression of class II antigens initiate the rejection process in skin transplantation.

**Dermis**

The dermis is a complex network comprising cellular and acellular components.This layer provides skin with its durability and elasticity.Structurally the dermis consists of two sublayers s superficial one (the papillary )and a deeper one (the reticular dermis). Collagen is the major

structural matrix molecule,constituting approximately 70% of the skin‘s dry weight.Elastic fibers account for approximately 2% of the skin’s dry weight and play an important role in maintaining the integrity of the skin after mechanical perturbation.[1] Glycosaminoglycans (GAGs),the third major extracellular component of the dermis , regulate intracellular and intercellular events by binding to,releasing and neutralizing cytokines and growth factors.The fibroblast is the principal cell of the dermis and is responsible for synthesis and degradation of fibrous and elastic dermal proteins.

**Basement membrane zone(bmz)**

The BMZ is a complex region of extracellular matrix connecting the basal cells of the epidermis with the papillary dermis .At the light –microscopic level,the dermal –epidermal junction consists of protrusions of dermal connective tissue known as dermal papillae ,which interdigitate with epidermal projections known as rete ridges .The structure of the BMZ is best appreciated on electron microscopy, where it appears as a trilaminar zone consisting of a central electron-dense region (the lamina densa) flanked on both sides by regions of lower electron density. On the dermal side of the basal lamina are numerous anchoring fibrils, which reach from the lamina into the connective tissue of the dermins. The BMZ plays a significant role in burn wound healing;

## BURNS CLSSIFICATION

A burn is a tissue injury from thermal (heat or cold) application or from the absorption of physical energy or chemical contact.The types of burns and tissue injury caused are listed below .

| **Type of Burn** | **Tissue injury** |
|---|---|
| Scalds | Partial thickness or deep dermal skin loss |
| Fat burns | Full thickness skin loss |
| Flame burns | Partial/Full thickness skin loss |
| Electrical burns | Full thickness with deep extensions |
| Frostbite | Tissue freezing and damage and Vasospasm |
| Ionizing radiation | Tissue necrosis and later dysplasia |
| Chemical burns | Inflammation, necrosis and allergic response |

Heat burn can be classified into

1. Partial thickness Burn

2. Full thickness Burn

**Partial thickness burn**

Burns in which only part of the dermis is involved. They heal by epithelialisation and without scarring but there may be some alteration in the texture and pigmentation of the skin.

**Full thickness burn**

Deep burns which destroy all the dermal elements. So there is no reactive erythema and the skin is often white in color. There is no skin sensation. Always heal by scarring and need skin grafting.

First degree: Involvement of epidermal layer only.

Second degree burn

1. Superficial
2. Deep

**Superficial second degree burns:**

Here epidermis and papillary layer of dermis are involved. It is characterized by severe pain, hyperaesthesia and blister formation. These burn wounds heal in 14-21 days with minimal scarring if infection is avoided but pigment changes may occur later.

**Deep second degree burns**

These burns involve the epidermis and almost the whole of the dermis leaving only the skin appendages (Pilosebaceous units, sweat glands). The wound is waxy, white, soft and elastic. It heals in 4-6 weeks time by hypertrophic scarring. These wounds are in danger of getting converted to full thickness burns by infection or drying.

**Third degree burns (full thickness):**

These burns involve the epidermis, dermis and the subcutaneous tissue. They appear white, cherry red or block. They form a tough, dry, inelastic, translucent and parchment like “eschar”. Thrombosed veins may be visible through the eschar. The nerve endings are destroyed and so become painless and insensitive. The eschar usually separates from the wound in 3-4 weeks to leave a granulating wound. These wounds undergo wound contraction due to severe scarring. They need skin grafting for closure.

**Fourth degree burns:**

Burns involving fat, fascia, muscle and bone.

The burns can also be catergorized as follows for further management.

**Critical burns:**

(1) Partial thickness burns more than 5% TBSA in infants, more than 15% TBSA in Children and more than 25% TBSA in adults.

(2) Full thickness burns more than 3% TBSA in children and more than 10 % TBSA in adults

(3) Burns with inhalation injury

(4) Burns involving face, hands and genitalia

(5) Burns complicated by head injury, abdominal and chest injury

(6) Electrical and deep chemical burns

**Moderate burns**

- Partial thickness burns of 10-15% TBSA in children and 15-20% of TBSA in adults.
- Full thickness burns of 1-3% TBSA in children and 3-10% TBSA in adults.

**Minor burns**

- Partial thickness burns of less than 5-10%TBSA in children and 10-15% in adults.
- Full thickness burns of less than 2% TBSA in adults.

  Patients with minor burns are managed on an outpatient basis while other patients are admitted and critically burned patient are preferably kept in an intensive care unit.

# PATHOPHYSIOLOGY OF BURNS

A burn injury not only destroys the cutaneous barrier but it also leads to profound changes in almost all other systems including psyche. So burn injury has been considered to be the "Universal Trauma Model".

The deleterious effects of burns injury on the organ systems are proportional to the extent of burn. The biphasic changes (early hypofunction and later hyperfunction) in organ systems may be clinically well identified in patients with more extensive burns.

## Mechanism of thermal injury

Thermal injury occurs as a result of transfer of energy from a heat source to the human body. The magnitude of tissue destruction is a function of the quantity of heat transferred and the speed at which it dissipates.

## Pathophysiology of the local burn injury

Human skin will tolerate temperatures up to 40 deg C for brief periods of time. Temperatures above this level result in a logarithmic increase in tissue destruction, irrespective of the time of exposure. The depth of burning is determined by the combination of the burning agent, temperature and the duration of exposure.

**Jackson described three zones of thermal trauma**

| | | |
|---|---|---|
| (i) | Central Zone | a zone of coagulative necrosis |
| (ii) | Peripheral Zone | a zone of hyperemia due to vasodilatation and altered permeability |
| (iii) | Intermediate Zone | a zone of stasis due to sluggish microcirculation and progressive ischemia |

The cells in the zone of stasis usually progress to death in 24-48 hours.

A number of systemic and local factors affect this progression to death.

**Systemic factors**

Depletion of intravascular volume

Depressed myocardial contractility

Reduction in stroke volume

**Local factors**

Circumferential constricting eschars

Interstitial edema

**Vascular factors**

Vasoconstriction

Endothelial damage

Microthrombi formation

Denaturation of cellular proteins occurs only when the temperature exceeds 45 deg C at which temperature the denaturation exceeds the ability of the cells to repair damage. At this temperature thermolabile enzyme systems are blocked and when the enzyme activity decreases to 50% of the normal, cell death occurs. The response of the cells involved in burns is neither uniform nor static. The blood supply and the local environment of the wound will help to determine the cell response. Additional trauma, edema, decreased vascular supply bacterial invasion will further injure or destroy cells that initially survive the thermal injury. In addition to cell damage there are both immediate and delayed vascular and cellular inflammatory responses at the burned site. Accumulation of fluid in the burn wound, the fluid and electrolyte shift within the wound are due to a series of mediators released following thermal insult. These mediators include vasoactive amines, prostaglandins, thrombaxanes, leukotrienes, oxygen radicals and lymphokines such as IL-1 and IL-2.

Immediately following burn injury spasm of venules, vasoconstriction of arterioles and dilatation of capillaries occur; capillaries and venules become permeable allowing leakage of fluid, electrolyte and proteins. This immediate response is followed within 6 hrs by a delayed response with venular dilatation and further capillary permeability. The most rapid fluid loss occurs during the first 12 hours postburn and is accompanied by cell margination and emigration as seen in inflammation. Another cause of fluid loss into the burn wound, besides, capillary permeability is the breakdown of the cell membrane by thermal injury which injures the sodium pump, resulting in cellular edema and decrease in cell function. There will be local and generalized edema in the burn victim. The edema is due to profound and widespread vasodilatation affecting the microvasculature and decrease in the oncotic pressure due to protein loss.

**Systemic response to local injury**

As the above events take place at the site of burn, systematic changes also take place simultaneously some time very rapidly to cause death of the patient. Some of the changes are related to the burn itself and some are in response to the stress of injury.

**Cardiovascular response**

Profound changes occur in the heart and vessels immediately following burns. A perceptible drop in cardiac output of up to 50% occurs. It was originally thought to be due to an unidentified myocardial depressant factor but now it appears to be secondary to changes in the intestitium in the wound and adjacent unburned tissue. A direct toxic effect of burn or burns by products can cause myocardial failure.

An increase in total body capillary permeability occurs in patient with greater than 30% TBSA. The lung vasculature may be the only tissue spared. The fluid-electrolyte-protein loss renders Starlings hypothesis ineffective and the fluid enters the functional third space. Fully 60% of the ECF may be lost in a major burn through capillary permeability, the ICF shifting into the heat injured cells and evaporation following destruction of the skin barrier. Most of the loss occurs within the first 8-12 hors but massive fluid losses continue for at least 48 hours after injury. The fluid loss in to the functional third space results in hemodynamic instability or burn shock.

Besides the fluid portion the cellular components also show a predictable change. Progressive anaemia occurs which may be due to direct red cell destruction by heat, decreased red cell survival, depression of bone

marrow, increased trapping of red cells by R.E. system and tendency to thrombus formation. Platelet changes are biphasic. An initial thrombocytopenia is followed by a prolonged thrombocytossis.

**Pulmonary response**

Respiratory system injury may be due to lack of oxygen secondary to combustion, inhalation of noxious gases, direct injury by heat and injury caused by hypoxia induced free radicals and arachidonic acid metabolites. Burn shock also leads to ventilation and perfusion mismatch which leads to inadequate peripheral perfusion and lactic acidosis. This results in cell damage and thrombosis in capillaries. As resuscitation establishes adequate flow, these products are pushed back into the venous circulation to be cleared by the already injured lungs. Effective resuscitation may result is a weight gain of 15-20% which make the chest wall heavy and hard to move. This excursion is further limited if an unyielding leathery eschar is present on the anterior chest. There is also hyperventilation due to increased oxygen needs and a ventilation perfusion imbalance.

**Renal response**

Kidneys respond to burns as in any trauma. Maximal reabsorption of water and sodium occurs simultaneously because of ADH release from posterior pituitary and aldosterone release from the adrenals. This results in excretion of a small concentrated urine containing low sodium concentration. The injured cell of burn wound release myoglobin, hemoglobin and other toxic products. If an adequate GFR is not maintained or if renal ischaemia occurs the toxic products are not effectively removed and acute tubular necrosis ensues.

**Gastrointestinal response**

The initial response of the gastrointestinal tract is a reflex ileus due to splanchnic vasoconstriction which resolves in 2-4 days. Gastroduodenal mucosal ulcerations may also occur in major burn. This is due to relative hyperacidity and due to mucosal ischaemia resulting from decreased splanchnic flow.

**Neuroendocrine response**

Adrenaline and nor-adrenaline are released in great amounts following thermal trauma. This appears to be a protection mechanism since the mortality is very high in burn victims who can not sustain this increased

response. But this may lead to post burn cardiac dysfunction and death resulting from catecholamine mediated hypermetabolism to tachycardia and hyperdynamic cardiac activity.

**Metabolic – nutritional response**

The metabolic rate of burn victim is greatly accelerated. Hypermetabolic response include increased oxygen consumption, increased nitrogen loss, protein catabolism, ureagenesis, lipolysis and increased gluconeogenesis.

The hypermetabolic state following burning results in profound catabolism with decreased glucagon insulin ratios and extreme intracellular cation alterations. Intracellular sodium concentration rises and will remain high unless at least 5000 calories/day are administered. The negative nitrogen balance accompanying hypermetabolism needs upto 20 gms nitrogen per square meter of TBSA per day during the first month after burn. This nitrogen need results from both increased catabolism and decreased protein synthesis.

Counter regulatory hormones glucagon, cortisol and catecholamines are elevated and play a major role in mediating the catabolic response. These hormones along with various inflammatory mediators released from the burn

wound, appear to be responsible for the various metabolic responses that occur after a major burn.

**Immune response**

Both cellular and humoral immunity have been defective in major burns. Impaired cell mediated immunity is suggested by lymphocytopenia, an increase of T-suppressor cells, a decrease in interleukin-2. An increase in immune suppressive substances in burn sera also occurs.

They include arachidonic acid metabolites, interferons, bacterial endotoxin, cutaneous burntoxin, denatured protein, metabolic hormones, histamine, serotonin, Immune complexes and complement. Humoral defects include depression of immunoglobulin and complement titres. Other immunological defects include depressed inflammatory reaction, inhibition of neutrophil chemotaxis, defective phagocytosis and killing of bacteria.

**Psychiatric response**

Psychiatric response depends largely on the patients pre burn personality. Situational depression is a uniform response but true psychosis is unusual. Temporary toxic psychotic symptoms accompany the other physiological alternations such as shock, hypoxia, water imbalance, electrolyte disturbance and sepsis. Anxiety over the uncertainty of survival,

sleep deprivation and intense pain can all trigger various responses of psyche.

**Pathophysiology of burn shock**

Increase in capillary permeability leading to fluid and protein leakage from the intravascular compartment.

- Decreased plasma oncotic pressure due to protein loss and hypoperfusion.
- Increased capillary hydrostatic pressure due to vasoconstriction or is partial blockage of vessels with aggregation of cells and platelets.
- Reduced clearance of fluid and proteins from the interstitial space due to blockage of lymphatics by platelets and fibrin clots.
- Intracellular fluid accumulation due to impaired cell function
- Increase in burned tissue osmotic pressure leading to future fluid accumulation
- Increased evaporative water loss
- Depressed myocardial function.

## INITIAL TREATMENT OF BURNS VICTIM

The most effective course of action with regard to burn is to prevent it from happening. But once it has occured immediate step should concentrate is to.

(1) Stop the burning process to prevent further injury.

(2) Do not further harm

(3) Recognize associated injuries

The following steps may be carried out to achieve these.

(i) Remove of the victim from the site of fire.

(ii) The fire is best smothered by pouring water on the burning victim. It rapidly cool down hot objects including human skin. The water should be poured on a burnt skin intermittently to reduce the burning sensation, to minimize the damage and to disperse heat. Application of cool water should be for a short time only because it may lead to hypothermia. Application of ice is not recommended as it can cause vasoconstrictive effect and freezing which aggravates damage to tissue.

(iii) Remove the victim to a smoke free area.

(iv) Remove the charred and the partly burned cloths and jewels on the patient.

(v) Patient should be wrapped in a clean dry cloth to minimize contamination and to diminish pain from exposure to air.

(vi) Avoid giving any oral fluids as it may induce vomiting and that may result in aspiration.

Associated injures like fractures should be dealt with. Fractures are splinted and bleeding points gently compressed.

If oxygen is available it should be administered and the patient should be transported to the nearest burn care center.

## CLINICAL EVALUATION OF BURN INJURY

Accurate assessment of the burn injury is not only crucial to the management but is also an important factor to indicate prognosis. The process of assessment and recording is essential throughout the treatment to know the progress of the patient. Accurate recording is useful in the court of law as legal evidence and is also essential in settling insurance claim and workers compensation after death.

Assessment of patient fall into two main categories.

1. History and physical examination.
2. Assessment of burn wound.

### History and physical examination

A detailed and pertinent clinical history should be elicited and recorded which includes the following apart from the basic information like Name, Age, Sex, Address, Occupation, Social and marital status.

1) The cause of burn – Flame, Electrical or chemical and the causative agent
2) Place of occurrence
3) Time of incident and time elapsed since burning.

4) Symptoms since burn like vomiting, convulsions etc.
5) Details of first aid and status of tetanus prophylaxis
6) Any preexisting medical illness, any treatment history or and history of drug allergy
7) Preexisting mental status.

Physical examination is done rapidly to assess the general condition and to decide whether they need hospital treatment.

i) Vital signs should be checked and recorded- Temperature, pulse Respiration and blood pressure
ii) Mental status-degree of alertness, presence of confusion, delirium, stupor and coma
iii) Status of the cardiovascular, respiratory system and abdomen.
iv) Any associated injury to musculoskeletal system.

**Assessment of burn wound**

This includes the estimation of

- ❖ Extent of burn
- ❖ Depth of burn

**Extent of burn**

The extent of burn is expressed as a percentage of TBSA. Many methods have been devised for estimating the extent of burns but the most popular of these methods in adult is the "Rule of Nine" described by Pulaski and Tension (1949) and later modified by Wallace (1951) which is very useful in estimation the burned area quickly. According to this method the body is divided into

| | | |
|---|---|---|
| Head and Neck | - | 9 % |
| Upper limbs (9x2) | - | 18% |
| Lower limbs (18x2) | - | 36% |
| Anterior Trunk | - | 18% |
| Posterior Trunk | - | 18% |
| Genitalia | - | 1 % |

Patient's palm with fingers close together is roughly equal to 1% which can be used for assessing scattered areas of burn. In children the size of the head is larger compared to the lower limbs. As the age advances this proportion keeps changing till 12 years, when it reaches the adult level. For estimating the extent of burns in children Lynch and Blocker (1963)

developed “Rule of Fire”. This works very well in infants where the head, anterior trunk and posterior trunk are all 20% each and each limb constitute 10% for children, this is slightly modified. Head, posterior trunk and lower limbs 15% each, 20% for anterior trunk and 10% for each upper limbs. Land and Browder (1944) developed a chart for the estimation of burns. Thought it is a tedious one it provides a rather accurate estimation of the extent of burns.

**Depth of burns**

Besides being a prognostic factor it is essential to gauge the depth of burn to ascertain if the wound is going to heal from epithelial remnants or else require skin grafting for closure. The depth of the burn is determined by many factors. They include

1) Causative agents : Scalds and UV radiation burns are usually superficial. Burn due to flames and electricity are usually deep. Acid and other chemical burns may involve the full thickness of skin.
2) Duration of contact : more the duration of contact deeper the burn
3) Location of Burn wound: Inner surface of arms, thighs, eyelids, dorsum of hand and genitals where the skin is delicate are predisposed to deep burns compared to palm, sole, back and scalp where the skin is thick.

Burns have been classically divided into First Degree, Second degree, Third degree and sometimes Fourth degree burns.

| | | |
|---|---|---|
| First Degree Burns | : | Limited to epidermis |
| | | Erythema |
| | | Painful |
| | | No Blisters |

**Second degree burns:**

| | | |
|---|---|---|
| Superficial | : | Epidermis and superficial dermis |
| | | Red and moist appearance |
| | | Blisters present |
| | | Blanch on finger pressure |
| | | Pain, hyperesthesia |
| Deep | : | Epidermis and whole dermis except appendages |
| | | Mottled appearance with white areas |
| | | Dry and may be insensitive |
| | | No balancing on finger pressure |

**Third degree burns:**

Epidermis, Dermis and subcutaneous tissues

Eschar formation – dry, leathery and translucent

Insensitive

Thrombosed veins

No balancing on finger pressure

**Fourth degree burns:**

Involvement of deep tissues like muscle and bone.

Clinically it is difficult to assess the depth in early cases with accuracy. Superficial appearance is unreliable for diagnosing the depth of the burn as the superficial looking areas may become deep due to ensuing thrombosis and edema. Pin prick test is a useful method of assessing the depth. This test should be interpreted with due consideration of the findings. Various techniques have been tried to delineate second and third degree burns such as using fluorescent dyes, radioactive materials, thermograph and biopsy. Though these methods may be helpful they are not practicable due to high technical difficulty and errors. These techniques are not routinely followed in most burn centers.

## INITIAL MANAGEMENT & MONITORING OF A BURN VICTIM

After assessing the extent and depth of the burns the patients are then classified into the following categories for further management.

1) Critical burns
2) Moderate burns
3) Minor burns

Patients with minor burns are managed on an outpatient basis. All other patients are admitted and critically burned patients are preferably kept in an intensive care unit.

All patients are covered with a sterile sheet and an intravenous line is established. In a large percentage of patients this is easily done with an intravenous canula, preferably through unburned skin. Venesection should be done in those who are critically ill. Venesection is preferably done in the upper extremity as it also facilitates CVP monitoring. If latter is necessary the canula tip is guided far into the superior vena cava and at the other end a water manometer is attached. The single most important factor essential for the survival of a burned patient in the initial period is the maintenance of an optimal blood volume. There is no satisfactory method in clinical practice for monitoring blood volume, cardiac output and vascular tone to identify and

correct specific defects that occur. An excellent assessment of the extent of hemodynamic abnormality can be obtained by measuring cvp and its response to a rapid trial infusion.

Tetanus prophylaxis is given. Antibiotic injections especially penicillin derivative may be given for a few days. An indwelling urinary catheter is placed in all patients. Oral fluids are restricted in patients with major burns for fear of causing distension and aspiration. Antacid and H2 blockers are also given as a routine. Restless patients are sedated only after hypoxia has been excluded or treated. Patients in shock are given sedation by intravenous route and intubated if needed.

Local care of the wound is begun only after shock is corrected. Wounds are cleaned with antiseptic solutions like betadine and normal saline. Blisters are deroofed. Silver sulphadiazine cream is applied and wounds dressed.

**Monitoring of the patient**

**In first 48 hours**

In this period intensive monitoring is essential to maintain fluid and electrolyte balance. During this period of resuscitation the patient will be loaded with crystalloid containing fluids which may result in sodium load

and hypernatremia. The patient is observed for level of consciousness and restlessness. Blood is drawn for grouping and cross matching, full blood count, glucose, urea nitrogen and electrolytes. Arterial blood gases and pH are obtained if there is any suspicion of inhalation injury or respiratory dysfunction. Pulse, BP and temperature chart is maintained. CVP monitoring is quite useful in extensive burns when large volumes have to be rapidly infused and also in patients who have pre-existing cardiopulmonary or renal problems. Urine output should be monitored on an hourly basis and should be maintained at 1ml/kg/hr. The urine should be maintained in an alkaline range and therefore urine pH estimation becomes mandatory.

**After first 48 hours**

By this time the patient should have been adequately resuscitated. Pulse rate and blood pressure stabilize and sensorium becomes clear. If bowel sounds are present the patient is started on oral fluids, Haemoglobin and hematocrit estimation at this time can resolve the need for blood transfusion. Serum electrolyte estimations are carried out as long as the patient is on intravenous fluids. Besides these parameters which are carried over from the intensive phase the patient is also monitored for

- ❖ Development of infection
- ❖ Nutritional status
- ❖ Psychological and social factors

Temperature recording assumes greater significance. A high spiking termperature record is one of the earliest sign of infection. Surface swabs are taken from the wounds for culture and sensitivity tests. In advanced burn care centers wound biopsies are carried out for quantitative estimation of bacteria per gram of tissue. Bacterial count in excess of $10^5$ per gram of tissue with invasion of subjacent unburned skin singnifies invasive infection. At spikes of temperature, blood samples are also sent for culture and sensitivity tests. Antibiotics are started according to culture and sensitivity.

The patients loss weight rapidly following the resuscitative phase. Although initially this is due to diuresis, subsequently patients loss weight due to poor dietary intake, high basal metabolic rate and the catabolic state.

Enteral feeding should be considered and a careful balance of protein-calorie requirements and the actual intake is maintained.

Once the patients are on the road to recovery the influence of psycho-social factors also assumes importance. Social factors leading to burns need to be evaluated and their effect on patients return to society have to be

discussed. How a patient psychologically reacts to injury also has a bearing on healing and rehabilitation.

**Fluid resuscitation and electrolyte management**

The timely restoration of intravascular volume with adequate amount of an appropriate fluid is critical for the survival of a patient with major burns. Fluid resuscitation should be initiated as soon as possible in all patients with burns of 15% or more TBSA. Since ileus occurs in nearly all such patients oral resuscitation is precluded and the fluids must be infused intravenously. A large bore canula should be placed in a vein (preferably a vein beneath unburned skin), to permit unimpeded fluid flow. Local care of the canula site is very important to prevent thrombophlebitis.

**Burn resuscitation formulas**

Most of which are based on the weight of the patient and the extent of the burns have been proposed for estimating fluid needs. The commonly used formulas are shown in the table.

**Fluid resuscitation - first 24 hours – crystalloid vs colloid**

Several studies have indicated that during the first 24 hours after burning colloid containing fluids are not essential for resuscitation because during this period, colloid containing fluid appear to be retained within the circulation to a greater extent than as equal volume of colloid free electrolyte containing fluid such as Lactated Ringer's solution.

1. Though colloid containing regimen restored cardiac output more rapidly than did crystalloid solution alone, at the end of 48 hours post burn the two resuscitation regimen were equally effective in restoring cardiac output and intravascular volume.
2. Deleterious effects of colloid containing fluid on lung-Extravascular lung water remain essentially unchanged during the first postburn week in those patient who initially received only crystalloid containing fluid but increased significantly above normal in patients who received colloid containing fluid as a component of initial resuscitation.
3. Late pulmonary complications and mortality are also higher in colloid treated patients.

During the first 24 hours post burn colloid free electrolyte containing fluid administration is more prudent. Lactated Ringer's solution is the best to meet the needs. various saline solution including hypertonic saline may also be used. The quantity to be infused in the adults are estimated by the commonly used formulas. It ranges from 2-4 ml per kg body weight per percent burn. As the capillary permeability is maximally increased immediately post burn with gradual restoration of functional capillary integrity during the first 24 hours, half of the volume calculated for first 24 hours post burn should be infused in the first 8 hours after injury and remaining half over the next 16 hours.

**Next 24 hours**

Following return of cardiac output at 24 hours there remain a plasma gap. This amounts to approximately 0.3-0.5 / kg / % body burn. By 24 hours capillary integrity rations and Starlings hypothesis appears to be restored. Therefore colloid can be used to replete the plasma volume. The commonly used colloid solution is salt free albumin diluted to physiologic concentration in normal saline i.e. 5gm in 100 ml which is administered as follows.

0.3 ml / % / kg for patients with 30 – 50 % burns

0.4 ml / % / kg for patients with 50 – 70 % burns

0.5 ml / % / kg for patients with more than 70 % burns

Since the patient will be loaded with sodium during the first 24 hours, (which may result in hypernatremia) to avoid further sodium load during the next 24 hours, along with colloid solutions, electrolyte free solution such as 5% dextrose in water is infused in a volume to maintain urinary output, while covering evaporative water loss and meeting metabolic needs.

**Monitoring of fluid resuscitation**

Adequacy of fluid and electrolyte resuscitation is determined by clinical observation and not by the ability to fulfill an arbitrary formula. A urine output of 30-50 ml/hr in an adult or 1ml per kg per hour in children in the best monitoring parameter. If the urine output does not reach these levels the fluid input must be increased and urine flow in excess of these parameters prior to mobilization of the edema reflects fluid over load. In addition to urine output, the burn victim who is being adequately resuscitated should have a clear, lucid sensorium, a pulse rate less than 120 and a haematocrit less than 50%

## INTIAL MANAGEMENT OF BURNS INVOLVING SPECIAL AREAS

The face, ears,hands,gentials and the feet have functional and cosmetic significance that far exceeds their size .Burns of these areas need special attention and this should be initiated early during the treatment.

### Face Burns

- Suspect inhalation injury in patient with burns of face .
- After proper cleansing ,apply collagen sheet in a patient with superficial partial thickness burns, if seen within 6 hours of injury.
- Deep partial or full thickness wounds may be treated by exposure with silver sulfadiazine cream smear or may be covered with face mask of nonadherent dressing and gamgee cotton pads.
- $30^0$ propped up position. Insert Ryle's tube for feeding.

### Eye Burns

- History of mode of burns and eye examination.
- Observe for singed eyelashes,eyebrows, eyelid edema, conjunctival lacerations.corneal opacity, and foreign body, pupil size and reaction to light.

- If chemical injury is suspected, irrigate the eye with Normal Saline 0.9% for 15-20 minutes.
- Application of ophthalmic antibiotic ointment 6-hourly reduces risks of corneal drying and infection.
- Cover the eye with eye shield and NOT with gauze and cotton pad.
- Repeat examination daily to look for corneal ulcer, abscess or other complications.
- In the event of cornel injury or with severe burns of the eyelids,an ophthalmologist's opinion should be obtained.
- Early tarsorrhaphy should be avoided as it increases lid deformity and prevents serial examinations of the corneal surface.

**Ear Burns**

- History of burn injury and examination of ear
- Examine the auricle for edema, tenderness and look for discharge from canal.
- If blisters are present, puncture them and expel the fluid out but avoid removing any skin which is still firmly attached.
- Avoidance of any pressure on the burned auricle is essential. Pressure is the biggest co-factor in the production of chondritis.

- Apply paraffin gauze into the canal and apply povidine iodine ointment on the burnt pinna.Wrap the ear with nonadherent dressing and gamgee cotton pad.
- Most ear burns respond well to conservative treatment ,although occasionally immediate coverage of exposed cartilage with a temporoparietal facial flap and skin graft may be required to salvage the pinna.

**Hand Burns**

- Hand burns assume a high priority from the onset of care.
- During the first 24-48 hours,adequate blood flow must be ensured. The consistency, the temperature and the presence of pulsatile flow detectable by Doppler ultrasonography should be regularly performed. If any doubt exists, escharotomy or fasciotomy should be performed.
- While dressing a hand burn, each finger should be wrapped individual with nonadherent tulle grass and web spaces should be separated.
- The hands should be splinted in a position of function: the metacarpophalangeal joints at $70\text{-}90^0$, the interphalangeal joints in extension, the first web space open and the wrist at $20^0$ of extension.

**Feet Burns**

- They require specific care: so admit the patient with burns to feet (especially circumferential burns).
- Assess the depth of the burns. Strict limb elevation of the involved extremity.
- Look for capillary refill to assess vascularity.
- Do escharotomy early to avoid gangrene of the distal part in patients with circumferential burns. Perform primary excision with skin grafting whenever possible .
- Apply antimicrobial cream and paraffin gauze in web spaces.
- Throughout the day encourage the patients for active as well as passive physiotherapy of ankle joint to prevent early contracture formation.

**Perineal burns :**

- Admission of this patients is necessary for specific care.
- Assess extent and depth of the burns. Look for the skin loss and edema.
- Per-urethral catheterization is essential to avoid contamination by urine.

# INHALATION INJURY

Inhalation injury and its complications are currently implicated in 30-80% of early burns fatalities. Children and elderly victims of fire have a greater risk of inhalation injury. Inhalation injury is a chemical laryngotracheobronchitis and acute pneumonitis due to the inhalation of smoke and other irritative products of incomplete combustion.

## Diagnosis

Inhalation injury should be suspected in any patient burned in a closed space. Other features which support the diagnosis of inhalation injury are burns of head and neck, a brassy cough, hoarseness, wheezing, bronchorrhea and production of carbonaceous sputum.

X-ray chest is not useful in the diagnosis of inhalation injury. Blood gas analysis will show hypoxemia and hypercapnoea. Blood carboxyhaemoglobin levels may be increased. The most reliable means of diagnosing inhalation injury is by serial fibreoptic bronchoscopy during the first 24 hours in suspected patients. The supra glottis airway is looked for sings of inflammation and for the presence of glottis edema. Evidence of mucosal inflammation and ulceration of the infraglottic airway as well as the deposition of carbon particles on the endobronchial mucosa.

**Treatment of inhalation injury includes consideration of the following**

1) Administration of warm humidified oxygen may be adequate for mild disease.
2) Airway : establishment of airway patency is best achieved by endotracheal intubation in more severe inhalation injury.
3) Fluid Needs : the fluid need may be very high in patients with inhalation injury. Administration of 50 % more than calculated resuscitation fluid volume to maintain cardiac output may be needed. This additional resuscitation volume is not associated with development of pulmonary edema and may even decreases lung edema by increasing shear rate in the pulmonary capillaries, thereby reducing neutrophil margination and the deleterious local effects of such cells.
4) Steroids : prophylactic steroid administration has no influence in the mortality or morbidity of the patient with inhalation injury and such prophylaxis has been reported to increase the occurrence of infection.
5) Antibiotics : systemic antibiotics are administered with a view to controlling infection especially against pseudomonas species as they are the predominant organism encountered.

## TOPICAL APPLICATIONS IN BURN WOUND

Attention should be directed to burn wound only after resuscitation has effected hemodynamic and respiratory stability. The burn wound should be cleansed using a surgical detergent, all loose nonviable skin trimmed away and all hair shaved away from the burned areas and from a generous margin of unburned skin. Following cleansing and debridement the topical agent of choice is applied.

### Strategy for topical antimicrobial therapy

A Protocal should be designed in a burn unit in the use of topical anti-microbial therapy which includes:

a.Easy availability of large quantities of the cream must be ensured.

b.The cream that is used must be useful against the bacteria of prevalence in the unit.

c.The bacteria that is the common offending agnet in the burn unit must be identified either staphylococcus or gramnegative rods.

d.The type of application that is to be adopted,as exposure of the wound with cream,or to be covered with closed dressing must be decided.

e.The topical agents can be alternated over a period of time.The cream either silver sulfadiazine,or framycetin is continuously used on all patients for a period of six months in the burn unit and later withdrawn for a period of three months,so as to prevent the development of resistance.After culturing the organisms and noting the sensitivity,the cream can be reintroduced into the unit.

f.Combination of creams ,alternating relays in the same patient can be used if cultural studies prove that the organisms are sensitive.But these combination therapies are not practical and usually not undertaken in large burn units.

**Topical antimicrobial agent**

The use of clinically effective topical antimicrobial agents has significantly decreased the occurrence of invasive burn wound infection and burn wound sepsis and effect that has been associated with improved survival of burn patients.

**Sulfamylon (mafenide acetate)**

This was introduced by moncrief in 1963. It is a methylated sulphonamide available as 11.1% water soluble and hygroscopic cream. It is bacteriostatic with a board spectrum of activity. Most gram positive and gram negative bacteria including staphylococcus, streptococcus,

pseudomonas and some strains of anaerobes are sensitive to this drug. It readily penetrates the eschar and establishes an effective concentration at the nonviable and viable tissue interface. These characteristics make it the best agent for treating patients on whom a dense bacterial population has developed in the eschar or those whose prior wound care regimens have failed to control the infection of the wound. The principal limitation of this drug result from its inhibition of carbonic anhydrase which promotes washing of bicarbonate by the kidney and accentuates post burn hyperventilation.This will lead to the development of acidosis and acid base imbalance. Its application is painful. Allergic reaction may occur and may necessitate discontinuation of therapy.

**Silver nitrate**

It has been used as an antiseptic for centuries – Moyer reintroduced it in 1965 as a 0.5% solution. At this concentration it has a significant and broad spectrum of antibacterial activity but no histiotoxicity. This does not penetrate eschar. It is applied by wet, soaked gauze pieces and the dressings are changed twice daily. The application is painless. Frequent change of dressing also leads to early separation of eschar. As the silver nitrate solution is made in distilled water, larger volumes of free water can get absorbed into circulation leading to water loading. It causes leaking of

sodium, potassium, chloride and calcium from the wound and may cause mineral deficits and alkalosis. So close monitoring of water and electrolyte management is essential during therapy. It also causes black discolouration of the wound and the linen.

**Silver sulphadiazine**

This is the most commonly used agent and is available as 1% cream. It was developed by Charles Fox in 1968. It is bacteriostatic and its spectrum of activity includes staphylococcus streptococcus, E-coli, Klebsiella species and pseudomonas. Its application is painless and it readily penetrates the eschar for effective control at sub eschar level. However it delays eschar separation. The principal limitation includes development of neutropenia which needs discontinuation of this agent and ineffectiveness against certain gram negative especially some strains of pseudomonas and nearly all enterobacter species.

**Gentamicin**

Gentamicin is an aminoglycoside ,and in 0.1% concentration in either ointment or cream base can be used over burn wounds .In a water soluble vehicle,it is supposed to release the drug effectively .The drug also gets absorbed systemically ,and hence occlusive dressings cannot be used with

gentamicin cream because,when it gets absorbed rapidly,during the interim phase between dressings,the burn wound is left unprotected.

The disadvantages are the accompanying ototoxicity on the 8th cranial nerve and nephrotoxicity.Rapid absorption of small quantities of the drug results in the emergence of resistant organisms.

**Cerium nitrate silver sulfadiazine**

Cerium is one of the lanthanide elements and is supposed to have a large invitro antibacterial and anifungal spectrum.Cerium nitrate was combined with siver sulfadizine as a water soluble cream with sulfadiazine,a little less than 1%.This was used on burns as a thin cream and wounds were covered, with dressing .The precise mechanism of action of cerium is not known. It merely provides a potentially active antimicrobial substance in vivo.But the disadvantages is that when it comes into contact with burn wound fluid,it becomes inactive.

**Framycetin sulfate**

As a 1%water soluble cream is found to be a prophylactic topical agent against most of the bacteria ,Particularly the staphylococcus as systemic absorption is very minimal and resistant strains have not emerged. There are no known serious toxic reactions,except rare cases of

hypersensitivity. Exposure method of treatment with framycetin cream is possible.

**Furacin (nitrofurazone)**

Furacin was first introduced during the second world war as a topical agent for surgical wounds ,burns,chronically infected wounds and donor sites.It is bactericidal and acts by inhibiting the enzymes necessary for bacterial carbohydrate metabolism. Antimicrobial spectrum extends to both gram positive and gram negative organisms.The advantages of furacin as a topical agent are that it penetrates rapidly through the eschar with minimal hypersensitivity.It has good gram postive coverage with low incidence of development of resistance.It disadvantages are that it is not active against pseudomonas and causes discomfort on application.

## SKIN GRAFTING

Where the wounds are less extensive and depth is uncertain it is advisable to manage the wound conservatively and to wait for the formation of granulation tissue as the slough separates from the wound. The wound infection needs effective control by topical and systemic antibiotic therapy.Three culture and sensitivity specimen should be negative prior to skin grafting. Once a clean granulating wound has been achieved the application of skin graft is a simple matter.

The amount of autograft available is determined not only by the extent of burns but also by the sites involved. Usually the skin graft is harvested from thigh, leg, arm, forearm, back and buttocks. However the graft may be harvested from almost anywhere including scalp, front of chest and abdomen.

Full thickness skin grafts are not used in the management of acute burns except in very small localized areas following wound excision. Split skin graft can be harvested by Humby's Knife or by a power operated dermatome. Although thicker grafts are better in quality, a thinner graft is generally preferred because of greater chance of graft taking up and also for

providing the possibility of reharvesting from the same donor site, if necessary, after reepithelialisation of the donor site.

For optimal utilization of the available graft an effective strategy has to be planned. Eyelids and hands should be grafted first for special functional reasons. Flexor areas over the joints take precedence over the extensor areas. However in extensive burns the areas likely to take the graft are covered first so that the total raw area is decreased at the earliest.

It is better to use large sheets of graft for better cosmesis and function especially on the face and hands. But it may not be possible to use sheet grafts if donor areas are limited due to very extensive burns. In these situations the following techniques are useful.

**Stamp grafting**

The skin is cut into small postage stamp size pieces and spread over the wound surface leaving gaps around each piece up to 1.5 cm. The wound epithelialises by outgrowth from the margins of islands of skin, once they have become established.

**Mesh grafting**

A number of mechanical devices are available which can expand the graft by 1.5 to 4 times, by making multiple cuts in the graft. Meshing also allows drainage of blood, pus or serum from under the graft. The raw area between the mesh heals very rapidly by epithelialization from fenestrated margins. Cosmetically the result is inferior to sheet grafting and even a well settled graft gives a characteristic appearance.

**Intermingled grafting**

In this technique autografts are used in combination with various substitutes (homografts, xenografts etc) so that the whole extensive area can be covered completely to arrest infection, prevent loss of nutrients and to promote anabolism.

This may be done by placing alternately the strips of autographs and homografts or by applying small strips of autografts and covering the whole area either by homograft, xenograft or amnion. In China, surgeons cover extensive raw areas with sheets of homografts or xenografts and through small holes made in it, they place pieces of autograft.

The biological material used with autografts is either subsequently removed or allowed to get rejected by immune response. After graft application, again the area may be left exposed or dressed. Pressure is not

essential for graft take. A thin graft sticks almost immediately on an ideal bed. If the graft is covered with a Vaseline gauze and is left undisturbed( it heals uneventfully even if completely exposed). This method is possible if the raw area is on one surface of the body only.

In the closed technique, after applying a layer of non-adherent Vaseline gauze, wet and squeezed gauze pieces are applied. They are covered by gamgee pads and a gently compressive dressing is done. Further immobilization may be necessary with plaster of paris splints.

The initial survival of graft depends upon imbibition of plasma like fluid from the graft bed. The graft depends on this plasma circulation for the first 48 hours. After this period the capillaries from the bed started joining the cut ends of the capillaries in the graft. Similarly the lymphatic circulation is also established. By fourth or fifth day a true circulation is established. Once the graft have been taken and the wounds have healed the area is kept lubricated by coconut oil or other moisturizing creams.

## SKIN SUBSTITUTES

Autologous skin graft remains the primary method of wound closure and is the gold standard for burn wound coverage. The paucity of available donor skin in extensive burns provided the impetus to look for materials that would provide temporary wound closure. So during the past few decades the use of biological and synthetic materials in the temporary closure of the wound has become common place.

The skin substitutes for temporary coverage can be divided into four categories.

1. Biological skin substitutes
    - Human allograft
    - Amniotic membrane
    - Collagen membrane/powder
    - Xenografts
2. Synthetic skin substitutes
3. Combined biologic and synthetic materials
4. Cultured autologous epidermal cells.

**Advantages of skin substitutes**

They provide temporary but useful coverage of burn wound during the critical phases of injury

1. They prevent desiccation of an open wound and decrease the evaporative water loss.
2. If the material adheres to the wound surface it can prevent the loss of plasma proteins.
3. Pain is decreased with the adherence of the biologic membrane.
4. External bacterial contamination is reduced.

**Disadvantages of skin substitutes**

1. They are only temporary covers.
2. Fluid can collect under the material and may get infected with the presence of endogenous bacteria.
3. Cost, availability and religious preference may preclude the use of some of the materials.

**Tissue cultured skin substitutes**

In vitro culture and growth of epidermal cells (keratinocytes) is the recent approach to find new sources of skin substitutes. The single cell

suspensions of human epidermal cells can be given on a collagen film into a confluent multilayered sheet of cells. The advances made in tissue culture technique make it possible to grow sheets of epidermal cells which can be used as autografts or allografts. Cultured epidermal cells lack Langerhans cells and MHC class II antingen and therefore, they are not antigenic and are long lasting when grafted. Cultured epidermal grafts also lack melanocytes and are devoid of skin appendages. A major limiting factor is the time taken (2-3 weeks) to grow sufficient size to cover a large burn wound. Keratinocytes from a piece of skin of 1-2cm can generate living tissue sufficient to cover the entire body surface.

## INFECTIONS IN BURN WOUND

Infection of wound is a major cause of death after burns. Even the most elaborated sterile technique fails to keep the wound free of microbial contamination.

### Source of organisms

The contamination of burn wound occurs from endogenous and exogenous sources. The patient's skin, upper respiratory tract and fecal contaminants constitute the endogenous sources. The exogenous sources include the hospital environment, cross infection and contaminants from hospital personnel.

### Organism

The common organisms causing infection are pseudomonas aeruginosa, Escherichia, Klebsiella, Proteus, Enterobactor and Providencia, staphylococcus aureus and sometimes group A streptococcus pyogenes. Anaerobic infections are rare in burn wound. Candida albicans and other fungal infections and viruses occasionally cause infection.

**Classification**

The burn wound infection may be classified as

Non invasive infection

Invasive infection

**Non invasive infection**

The infection is limited to burn eschar. It may lead to early separation of eschar and increased purulent discharge from the wound.

**Invasive infection**

Invasive burn wound sepsis is defined as the presence of organisms exceeding 1,00,000 per gram of tissue of the burned area and invading the subjacent unburned area. This stage occurs if the burn wound remains improperly treated. The sequential progression of bacterial involvement from the surface of the wound to the deep unburned tissue has been described as follows.

(1) Supra eschar colonization : The bacteria are present over the surface of eschar

(2) Intrafollicular colonization : The colonization occurs in the pits of destroyed hair follicles.

(3) Intra eschar and subeschar colonization : The microorganisms invade the coagulated and nonviable tissue.

(4) Invasion of subjacent unburned tissue. This stage is termed the burn wound sepsis.

**Local signs of non invasive infection**

Eschar separates rapidly

Profuse purulent discharge

Granulation remains pink

No changes observed in the unburned viable tissue.

Grafts may not take

**Local signs of invasive wound infection**

Conversion of second degree burn to full thickness necrosis

Focal dark brown or black discolouration of wound

Subeschar suppuration

Haemorrhagic discoloration of subeschar fat

Unexpected rapid eschar separation

Degeneration of wound with neoeschar formation

Erythematous or violaceous edematous wound margin

Crusted serrations of wound margins (herpetic infection)

Septic lesions in unburned tissue (Erythema gangrenosum – pseudomonas)

Failure to take graft

**Diagnosis of burn wound sepsis**

In addition to above mentioned features the investigations which can help in the diagnosis of burn wound sepsis included.

- Wound biopsy
- Surface culture
- Blood culture
- Leukocyte counts

**Wound biopsy**

The critical point in burn wound sepsis is invasion of the normal unburned tissue. Hence wound biopsy is the single best modality for monitoring the wound.

Biopsies are taken from areas which look clinically involved. The material is submitted both for quantitative culture and histology evaluation.

**Quantitative culture:**

The load of bacteria per gram of tissue can be known by these cultures. If the number of micro-organism is more than 100000 per gram tissue burn wound sepsis is imminent. The determination of susceptibility of bacteria to different antibiotics helps in selection of systemic therapy.

**Histologic evaluation**

About half of burn wound biopsy specimen is examined histologically. The histologic signs of burn wound infection have been described by Pruitt (1979) "Histologic criteria of Burn wound infection".

Microorganisms in unburned tissue

Hemorrhage in unburned tissue

Heightened inflammatory reaction in adjacent viable tissue

Small vessel thrombosis or ischaemic necrosis of unburned tissue

Perineural and intralymphatic migration of organism (Pseudomonas infection)

Vascultits with perivascular cuffing of organisms (pseudomonas infection)

Intracellular viral inclusions

**Surface culture**

Swabs taken from the surface of the wound are cultured to identify the organisms. But they fail to provide any information regarding the microbial status of the tissue underneath the eschar. In extensive burns different areas grow different types of microorganism. So repeated cultures are taken from different areas may help in identifying the organisms on the surface.

**Blood culture**

Blood culture may be necessary if septicemia is suspected in any burned patient. Negative cultures do not rule out septicemia as septicemia can occur without demonstrable bacteria because toxemia can result from the absorption of toxic products of bacteria.

## SURGICAL MANAGEMENT OF BURN WOUNDS

The procedures used in the surgical management of burns can be classified as follows

**Management of partial thickness burns**

Tangential excision and split skin grafting

Tangential excision and Biological dressing

Superficial escharectomy

**Management of full thickness burns**

Escharectomy

Radical excision and split skin grafting

Sequential excision and split skin grafting

**Early excision of burn wound**

With a clear understanding of the pathophysiology of burns availability of modern monitoring techniques, excellent anaesthetic care with better and safer drugs, effective topical and systemic therapy and use of blood transfusion, and aggressive approach to the burn wound has been developed over the last two decades.

Early excision of burn wound may be defined as that occurring within the first 7-10 days of injury. This involves excision of all the burned tissue (before it gets infected) down to a healthy bed and a simultaneous cover by autografts. This does not improve the mortality rate in major burns but the length of hospital say may be shortened. Before the operation it is important to have sufficient blood cross matched and to do a coagulation profile. A safer practice is to excise an area which does not put the patient general condition at risk. If there is an undue blood loss or when about one third of blood volume has been lost the excision should be curtailed.

This approach required an experienced team, patient selection and availability of all facilities. Deep dermal burns may be tangentially excised using a skin graft knife the wound is shaved in layers down to punctuate bleeding from the dermis, it is important to cover the whole tangentially excised area with split skin graft as any area left uncovered will desiccate and die. If this opportunity is missed deep dermal burns should be treated conservatively by conventional methods.

Though early excision has reduced the morbidity resulting from the deep dermal and full thickness burns with an extent of 40-60% TBSA, its role in extensive burns is questionable.

**Key points for escharotomy and fasciotomy**

- Remove constricting objects
- Immediate elevation of burned extremities
- Perform early escharotomies on circumferential full thickness burn
- Consider early fasciotomies for electrical burns involving extremities.
- Decreasing Doppler flow signal with adequate blood pressure or tissue pressure more than 25 mm Hg means escharotomy/fasciotomy is needed.
- Escharotomy is performed without anaesthesia while fasciotomy requires regional anesthesia.
- Escharotomy must extend completely through the burnt tissue.
- Hemostasis is obtained with pressure,cautery or microcrystalline collagen.

## ADDITIONAL COMPLICATIONS IN BURN CARE

- Pain
- Abdominal compartment syndrome
- Deep vein thrombosis
- Ventilator associated pneumonia
- Anaemia
- Psychiatric problems

### Pain management

Pain management for patients with burn injuries works best with simple pharmaceutical approaches. Burn patients experience three different classes of pain – background, break through, and procedural pain, which require different approaches.

Burn patients experience background pain 24 hours per day until their wounds are healed. Long – acting pain relievers are well suited like methadone or controlled – release morphine sulfate. An, outpatient with a small burn often does well with a non steroidal antiinflammatory drug (NSAID); NSAIDs should be stopped at least 7days before any surgery.

Breakthrough pain occurs when exercise or other activities of daily living exacerbate background burn wound discomfort. Short-acting narcotics

or acetaminophen can alleviate occasional breakthrough pain. Persistent breakthrough pain suggests that the long-acting medication dosage should be increased.Procedural pain occurs during wound care and dressing changes and usually rquires treatment with a short-acting narcotic. For outpatients, oxycodone (5 to 15mg) usually suffices for daily wound care.Anxiety about wound care or thereapy is often misconstrued as pain, especially in children. Therefore, patients with large burns requiring daily wound care should be evaluated for potential benefit from a short-acting anxiolytic agent for procedures.

Nonpharmacologic approaches can augment pain management in burn patients. Hypnosis can be administered either by trained healthcare providers or by patients themselves to reduce narcotic use.

**Deep vein thrombosis**

The incidence of deep vein thrombosis (DVT) has been reported to be as high as 25% in hospitalized burn patients. It has also been reported to be responsible for only 0.14% of deaths in burn patients hence a standard of care for DVT prophylaxis in burn patients has never been defined. At the University of Washington Burn Center, patients with burns large than 20% TBSA developed clinically evident thromboembolic disease in 9% of those

who received prophylaxis with unfractionated heparin and in 18% of those who received low-molecular-weight heparin (unpublished data). On the basis of these data, patients with burns larger than 20% TBSA receive prophylaxis with subcutaneous unfractionated heparin, 5,000 U twice a day. A dropping plated count suggests heparin-induced thrombocytopenia and can be associated with thromboembolic disease.

**Anaemia**

Acute blood loss soon after injury is uncommon in a patient with an isolated burn injury therefore; a dropping hematocrit during resuscitation may be a sign that a patient has associated injuries or a bleeding diathesis. Procedures such as central venous line placement or escharotomies should not be associated with significant blood loss. Patient age, overall condition, and co morbidity should contribute to the determination for the need of a transfusion. However, inhalation injury, severe infection, or unstable cardiac ischemia may require a higher hematocrit to maximize oxygen-carrying capacity. Patients with large burns and anticipated blood loss should receive iron supplements.

## RECENT TRENDS IN MANAGEMENT OF BURNS

- New techniques of planimetry and computer analysis and storage will soon allow accurate reproducible mapping of the surface extent of the burn.
- Fibreoptic perfusion flurometer may be useful in determined the depth of the burn wound accurately.
- Reflected light imaging, Laser Doppler flurometry, High frequency ultrasonic imaging and portable xenon-133 washout scans are being evaluated to predict accurately which cells are nonviable.
- Magnetic resonance imaging may prove valuable in evaluating the presence of viable versus nonviable tissue.
- Immunomodulators which can specifically reverse various lymphocyte and phagocyte abnormalities seen post burn are being evaluated in clinical trials eg. GCSF and IL-1, IL-2, IL-3, IL-4, IL-5 and IL-6
- The antioxidant glutathione when given as an aerosol to animals with an inhalation injury prevented an increase in plasma hydrogen peroxide, which produces the destructive hydroxyl radical.

- ❖ Understanding the role of various mediators of inflammatory response and modulating their effects pharmacologically may significantly lessen the volume of tissue destroyed by thermal trauma.

**Insulin**

Insulin may be used as an anabolic agent. Its use, combined with carbohydrate and aiming for normoglycaemia, resulted in a reduction in wound healing times and induced muscle protein synthesis.38, 39 Smaller doses of insulin have been shown to induce anabolism.

**Glutamine**

Enteral glutamine administration has been an area of research in trauma patients, and has shown promising results. There is increasing literature supporting its use in patients with severe burns. A recent small single-centre double-blinded randomised trial showed a significant reduction in infectious complications and mortality ($p<0.05$) in patients with severe burns.

**Beta-Adrenergic Receptor Blockade. (propranolol)**

- In burn patients, beta-blockers can blunt the catecholamine effect by attenuating hypermetabolism, decreasing oxygen demand and resting

energy expenditure, and decreasing heart rate and cardiac oxygen demand.

- Beta-blockers was associated with decreased mortality, wound infection rate, and wound healing time.

➢ **Oxandrolone**.

Oxandrolone is an analog of testosterone, which is an anabolic hormone. It has been used to treat muscle wasting in various disease processes such as acquired immune deficiency syndrome.

- 10 mg of oxandrolone every 12 hrs was associated with decreased hospital stay, enhance collagen deposition in acute respiratory distress.

➢ **Immunonutrition**.

- include arginine, glutamine, omega-3 fatty acids, and antioxidants suchas ascorbic acid (vitamin C) and -tocopherol (vitamin E).

Although many studies in burned animal models show improvement with a specific immune supplementation, there are no human studies to investigate the response in a clinical setting.

➢ **Recombinant Human Activated Protein C.**

- It's the first agent approved by the Food and Drug Administration for treatment of severe sepsis.

- **Topical Immunomodulation.**

- Topical inflammatory modulation in severe burns is attractive because it can be readily used in patients who are already receiving topical antimicrobial agents, and it may avoid some of the systemic complications

- **Recombinant growth hormone**

    - The use of recombinant human growth hormone especially in pediatric burn patients has shown improved outcome. Weight preservation, raised plasma level of albumin and transferrin and better control of infection have been observed.

- Vaccum assisted wound closure

- **Epidermal and dermal cells culture**

  Epidermal and dermal cells are being growth in tissue culture. As they grow they lose their antigenicity. This property allows experimental ways to store the cultured epidermal and dermal cells in tissue culture bank which can be utilised on demand.

- **Artificial Skins :** skin storage banks are available. By which we are using artificial skins in extensive burns.

# OBSERVATION AND DISCUSSION

## Epidemiology

Thanjavur Medical College is one of the terminal care institutes of the Health care Delivery system of this state. It provides health care to the patients coming especially from Thanjavur, Pudukottai, Thiruvarur, Nagappatinam and perambalur districts.

It is provided with a burn Care unit to which approximately 400 patients are being admitted for management every year. The following is the statistical analysis of the data of the patients treated here from 2010 to 2013. The following are the epidemiologically variables analyzed and presented here.

(1) Total admissions – every year

(2) Age distribution

(3) Sex distribution

(4) Extent of Burns

(5) Mortality Rates

**Total admissions**

| Year | Flame | Electrical | Total |
|---|---|---|---|
| 2010 | 349 | 37 | 386 |
| 2011 | 370 | 24 | 394 |
| 2012 | 390 | 36 | 426 |

**Age distribution**

| Year | < 13 Yrs | 14-20 Yrs | 21-40 Yrs | 41-60 Yrs | > 60 Yrs |
|---|---|---|---|---|---|
| 2010 | 10 | 68 | 252 | 38 | 18 |
| 2011 | 16 | 60 | 268 | 27 | 23 |
| 2012 | 20 | 75 | 280 | 38 | 13 |

**Sex distribution**

| Year | Male | Female | Total |
|---|---|---|---|
| 2010 | 119 | 267 | 386 |
| 2011 | 104 | 290 | 394 |
| 2012 | 106 | 320 | 426 |

## Extent of Burn (% TBSA)

| Year | < 30% | 30-50% | 50-70% | > 70% | Total |
|---|---|---|---|---|---|
| 2010 | 118 | 159 | 45 | 64 | 386 |
| 2011 | 114 | 163 | 49 | 68 | 394 |
| 2012 | 130 | 168 | 38 | 90 | 426 |

## Mortality (Total)

| Year | Total Admitted | Total Dead | % of Death |
|---|---|---|---|
| 2010 | 386 | 130 | 33.6 |
| 2011 | 394 | 148 | 37.5 |
| 2012 | 426 | 151 | 35.4 |

## Mortality (Sex distribution)

| Year | Total No. Death | Male | Female |
|---|---|---|---|
| 2010 | 130 | 28 | 102 |
| 2011 | 148 | 27 | 121 |
| 2012 | 151 | 19 | 132 |

1. The analysis of the epidemiological data of the burns patients admitted to this hospital since year2010 revealed the following conclusions.
2. Majority of the patients (nearly 90%) admitted to the burns care unit of this hospital belonged to the rural folks of Thanjavur and adjacent districts.
3. 95% of the patients treated here belonged to the low economic status of the society.
4. Nearly 90% of the cases are due to flame burns, while the remaining cases were due to electrical burns.
5. In 95% of the patients the mode of sustaining burn was recorded as accidental. Remaining cases were attributed to suicidal attempts.
6. 60-65% of the patients were females predominantly in the reproductive age group.
7. While most of the patients were adolescents and adults, pediatric and geriatric patients constituted about 10% of the patients.
8. 70-75% of the patients had sustained only less than 50% burns and 15-20% of the patients had more than 70% burns.
9. There was a substantial increase in the flow of cases with more than 70% especially during the past 3 years.

10. The average mortality was found to be between 34 to 38% every year which was remarkable constant since 2010.
11. All the patients who had more than 70% Burns died, 90% of the patients who had sustained less than 50% burns survived but only 10-15% of the patients who had 50-70% burns were able to thrive.
12. The mortality was very high in female patients and it was found to be 40% of the females admitted while it was 15-20% of the male patients admitted.
13. Most of the female patients had either suicidal history and few homicidal. Most of the homicidal incidents were initially denied by the patients but later on they confide the truth. It appears that the reluctance on the part of the patients was due to consideration of children when the accused is the husband.
14. The number of man-days lost and human resources lost are enormous considering that most of the patients are in the prime age group.

This study is a prospective clinical trial which analyze the differences in the outcome of the early burn wound care by two different method, viz.

- Open Exposure method vs
- Closed collagen method – using collagen as temporary Biological Cover

The patients are closely monitored during the study and observation made during this period are analyzed and discussed here.

**Mortality**

- In each group one patient died
- In Group I (Open method) a Female patient aged 40 with 45% burns, mostly second degree and third degree burns died on the 3rd day post burn.
- In Group II (Collagen cover) a male patient aged 42 with 45% burns mostly second degree burns died on the 4th day post burn.
- All other patients survived with observable differences in the morbidity variables.
- This indicates that either method dont influence the mortality rate on burn patients and mere application of collagen sheets does not reduce the mortality. Moreover mortality is not determined by a single factor like burn wound care and it is a product of multiple factors acting upon the burn victims.

**Morbidity**

The following morbidity are observed and analyzed

- Pain Relief

**Association between open and closed method of the respondents and their pain relief**

| Sl.n | Pain relief | Open | | Closed | | Total | | Statistical inference |
|---|---|---|---|---|---|---|---|---|
| | | *(n=30)* | *(100%)* | *(n=30)* | *(100%)* | *(n=60)* | *(100%)* | |
| 1 | Excellent | 0 | .0% | 12 | 40.0% | 12 | 20.0% | $X^2$=31.569 Df=3 .000<0.05 Significant |
| 2 | Better | 3 | 10.0% | 10 | 33.3% | 13 | 21.7%. | |
| 3 | Good | 12 | 40.0% | 8 | 26.7% | 20 | 33.3% | |
| 4 | Poor | 15 | 50.0% | 0 | .0% | 15 | 25.0% | |

**Statistical test:** Chi-square test was used the above table.

The above table reveals that there is a significant association between open and closed method of the respondents and their pain relief. Hence, the calculated value is less than the table value *(.000<0.05*)

Pain is an important morbid feature in any burned patients especially in first and second degree burns.

Almost all the patients in both groups experienced pain during the resuscitation period. The difference was best observed after 24 hours postburn.

In Group I (Open method) patients the pain relief was variable; Few patients (10%) had better pain relief following silver sulfadiazine application while most of the patients (40%) experienced lesser intensity of pain and irritation but demanded Analgesics and sedatives intermittently for a period of about 5-7 days and few patients (50%) had poor pain relief at all, demanding pain relief by pharmacological means for more than 10-14 days.

In Group II (Collagen cover) the pain relief was dramatic in the post resuscitation period in about 70% of patients while few patients (30%) complained intermittent pain demanding analgesics. The pain relief in this group was more marked in the pediatric age group patients. Almost all the pediatric patient become active and playful. Pain relief was well observed during the first 7-10 days post burn. Once the infection supervened the pain relief was variable.

**Collagen separation**

Immediately following application on the burn wound, collagen became adherent to wound surface in all the patients treated with collagen.

The adhesion was well observed 6-12 hours after application. There are dramatic pain relief experienced by most of the patients following collagen cover. This may be attributed to the adherence of the collagen to the wound and to the barrier function of collagen between the wound and the environment.

In the Group II (Collagen cover) patient the separation of collagen was noticed from the 5th day onwards. On separation the underlying wound was found to be epithelialised in first degree burns and found to have fine granulations in second degree and third degree burns.

Collagen separation on its own was complete in most of the patients (60%) or peeled off gently in few (20%) other patients after 10 to 14 days. But it needed complete removal in 10% of patients because of underlying infection. In these cases the collagen was removed on the 10th day post burn on suspicion of submembrane infection.

**Fluid requirements**

- Fluid requirement of the patients treated in both groups was calculated using parkland's formula.
- **Association between open and closed method of the respondents and their Fluid requirement (after 24hrs)**

| Sl.no | Fluid requirement (after 24hrs) | Open | | Closed | | Total | | Statistical inference |
|---|---|---|---|---|---|---|---|---|
| | | *(n=30)* | *(100%)* | *(n=30)* | *(100%)* | *(n=60)* | *(100%)* | |
| 1 | Not needed | 12 | 40% | 20 | 66.6% | 32 | 53.4% | $X^2$=12.462 Df=2 .010<0.05 Significant |
| 2 | on day 2 | 17 | 56.7% | 9 | 30.0% | 26 | 43.3% | |
| 3 | After 2days | 1 | 3.3% | 1 | 3.3% | 2 | 3.3% | |

- **Statistical test:** Chi-square test was used the above table
- **Inference:**
- The above table reveals that there is a significant association between open and closed method of the respondents and their Fluid requirement (after 24hrs). Hence, the calculated value is less than the table value *(.010<0.05).*
- The fluid requirement calculated and administered was found to be adequate to maintain the urine output of more than 30-50ml per hour during the resuscitation period in all pateints in Group II (Collagen)
- In Group I patients, about 40% of the patients required more volume of Ringer lactate to maintain the adequate urine output.

**Enteral feeding**

**Association between open and closed method of the respondents and their feeding started**

| Sl.no | Feeding started | Open | | Closed | | Total | | Statistical inference |
|---|---|---|---|---|---|---|---|---|
| | | *(n=30)* | *(100%)* | *(n=30)* | *(100%)* | *(n=60)* | *(100%)* | |
| 1 | Within 2 days | 6 | 20.0% | 20 | 66.7% | 26 | 43.3% | $X^2$=13.303 Df=1 .000<0.05 Significant |
| 2 | Delayed | 24 | 80.0% | 10 | 33.3% | 34 | 56.7% | |

**Statistical test:** Chi-square test was used the above table

**Inference:**

The above table reveals that there is a significant association between open and closed method of the respondents and their feeding started. Hence, the calculated value is less than the table value *(.000<0.05).*

- Enteral feeding was started on 2nd day in 70% 0f patients in this Group II (Collagen cover) as all of them were able to assimilate. They were initially given liquid diet on the 2nd day post burn and started on solid from the 3rd day onwards. Intravenous fluids were stopped at the end of 2nd day.
- Enteral feeding was delayed in 80% of the patients in the Group I (Open method) as they complained of vomiting abdominal pain and

discomfort during the first few days. They are continued on Intravenous fluids for few more days.

**Wound infection**

The wound infection was prevalent in almost all the patients studied in both groups. Wound infection was assessed and monitored by Pruitt's clinical criteria and by surface culture. Wound Biopsy was not done in all the cases under study. Biopsy was taken only in two patients (One patient from each group) for sample study. The biopsy material was sent for both bacteriological and histopathological assessment.

**Association between open and closed method of the respondents and their wound infection**

| Sl.no | Wound infection | Open | | Closed | | Total | | Statistical inference |
|---|---|---|---|---|---|---|---|---|
| | | *(n=30)* | *(100%)* | *(n=30)* | *(100%)* | *(n=60)* | *(100%)* | |
| 1 | + | 18 | 60.0% | 24 | 80.0% | 42 | 70.0% | $X^2$=2.857 Df=1 .091>0.05 Not Significant |
| 2 | ++ | 12 | 40.0% | 6 | 20.0% | 18 | 30.0% | |

**Statistical test:** chi-square test was used the above table

**Inference:**

The above table reveals that there is no significant association between open and closed method of the respondents and their wound infection. Hence, the calculated value is greater than the table value *(.091>0.05).*

The results were consistent with wound infection. No invasive infection was noticed in both cases. Surface cultures were taken on the 3rd, 7th and 14th day post burn. 80% of patients in group I (open method) showed positive culture on the 3rd day but only 30% of the patients were found to have wound infection on the 3rd day in collagen treated group. By 14th day all the patients in collagen group had infected wounds. But intensity of infection assessed by clinical criteria was less in the collagen treated group. Since the onset of infection was early and the intensity of infection was pronounced the treatment of infection in Group I (open method) patients was found to be difficult and protracted.

In all the patients treated by either methods, the infecting organisms were found to be the gram negative group only. They included proteus, pseudomonas, Klebsiella and E-coli in the descending order frequency.

It should be noted here that in two patients in Group II (collagen cover), there was subeschar infection in few areas of burn resulted in collection of pus beneath the collagen membrane and this necessitated the removal of the collagen from the wound to drain the pus. In these cases the invading organism was found to be pseudomonas which had responded to parental amikacin. So it should be stressed here that there is a possibility of overlooking the subeschar infection unless the wound is closely monitored.

All these observations clearly indicated that collagen cover did not prevent burn wound infection in the cases we studied but it delayed the onset of infection and the intensity of infection was also less.

**Wound healing**

**Association between open and closed method of the respondents and their wound healing**

| Sl.no | Wound healing | Open | | Closed | | Total | | Statistical inference |
|---|---|---|---|---|---|---|---|---|
| | | *(n=30)* | *(100%)* | *(n=30)* | *(100%)* | *(n=60)* | *(100%)* | |
| 1 | Good | 15 | 50.0% | 26 | 86.7% | 41 | 68.3% | $X^2$=9.320 Df=1 .002<0.05 Significant |
| 2 | Poor & delayed | 15 | 50.0% | 4 | 13.3% | 19 | 31.7% | |

**Statistical test:** Chi-square test was used the above table

**Inference:**

The above table reveals that there is a significant association between open and closed method of the respondents and their wound healing. Hence, the calculated value is less the than table value *(.002<0.05)*.

Areas of first degree burns healed rapidly in 4-6 days and epithelialization was good in patients belonging to both groups.

Clear granulating wound was obtained from the areas of second and third degree burns belonging to both group as the infection was brought well under control with judicious use of antibiotics. As the wound infection was less severe all the patients treated with collagen (except who had subeschar

infection) obtained clean and healthy granulating wound relatively quickly (15-20 days) than the patients treated by conventional open method, who took longer healing time (21-35 days). All the patients were referred to plastic surgery department for definite wound cover by skin grafting.

**Hospital stay**

**Association between open and closed method of the respondents and their hospital stay**

| Sl.no | Hospital stay | Open | | Closed | | Total | | Statistical inference |
|---|---|---|---|---|---|---|---|---|
| | | *(n=30)* | *(100%)* | *(n=30)* | *(100%)* | *(n=60)* | *(100%)* | |
| 1 | 15 to 20 days | 22 | 73.3% | 28 | 93.3% | 50 | 83.3% | $X^2$=4.320 Df=1 .038<0.05 Significant |
| 2 | 21 to 35 days | 8 | 26.7% | 2 | 6.7% | 10 | 16.7% | |

**Statistical test:** Chi-square test was used the above table

**Inference:**

The above table reveals that there is a significant association between open and closed method of the respondents and their hospital stay. Hence, the calculated value is less than the table value *(.038<0.05).*

During the study it was clearly noticed that the duration of hospital stay was comparatively less in patients treated with collagen than the patients in Group I (open method)

Early wound cover with collagen greatly lessened fluid, electrolyte and protein seepage through the burn wound, dramatic pain relief following

collagen application, early ambulation, early start of enteral feeding, delayed and less intense wound infection, good infection control, and shortened wound healing time prompted us for early discharge of patients treated with collagen than the patients treated with open method. This resulted in decreased hospital stay (15-20 days) for the patients in Group II (collagen cover) than the patient managed by conventional open method, who stay in the hospital comparatively longer duration (21-35 days).

## CONCLUSION

This study is a small sample clinical trial. The conclusions drawn up here are purely based on the statistical data obtained in the trial. These inferences may need further elucidation by larger clinical trials and follow up.

The comparative analysis of two methods of early burn wound care viz.

- Open Exposure method vs
- Closed collagen method – using collagen as temporary cover resulted in the following conclusions.
- There was no change in the mortality rate of both group patients studied. Mere application of collagen cover to the burn wound did not alter the mortality rate.
- The pain relief was generally dramatic and continuous in patients treated with collagen membrane as a temporary cover to the burn wound than the patient treated by open method.
- The need of analgesics, sedatives and anxiolytics was more in patients treated by conventional open method than the patients treated with collagen.

- ❖ Fluid requirement in the form of intravenous fluids during the post resuscitation period was more in patients treated with open method than the patients treated with collagen cover as fluid and electrolyte loss was comparatively less in these patients.
- ❖ Enteral feeding was started comparatively earlier in the collagen group than the patients treated with open method.
- ❖ Burn wound infection was prevalent in all the patients studied but the onset of infection was delayed and intensity of burn wound infection was relatively less in patients studied with collagen than the patient treated by open method.
- ❖ The wound infection should be carefully monitored if collagen is applied as there is always a small risk of hidden submembrane infection, which may be overlooked, posing a danger of severe sepsis.
- ❖ There was no observable change in the healing of First degree burns in both groups. But the healing time was relatively quick following collagen application in the second and Third degree burn areas.
- ❖ Duration of the hospital stay was also comparatively less in patients treated with collagen cover.

# PROFORMA

## MANAGEMENT OF BURNS WOUND – COMPARATIVE ANALYSIS OPEN EXPOSURE METHOD Vs CLOSED COLLAGEN METHOD

Patient's Name: - Age/Sex IP No:-

Address Date & Time of Admission :-

Date of Discharge: -

**HISTORY : -**

Date & Time of Burn :-

Cause of Burn :- Accidental / Suicidal / Homicidal

Social Status : - Occupation/Income

Family Status :- Married/Unmarried, Children –

Any preexisting mental illness –

**EXAMINATION : -**

Extent of Burns

Image

**DEPTH OF BURNS**

1st Degree :-

2nd Degree : - Superficial/ Deep

3rd Degree : -

**GENERAL PHYSICAL EXAMINATION**

Level of Consciousness hydration: - Pallor:-

Pulse BP Temp Resp. rate

Weight RS CVS Abdomen

**RESUSCITATION : - (FIRST 24HRS)**

Fluid Requirement (parkland's formula);

Total percentage body surface area X weight in kilograms X 4= volume in ml.

Half of this volume is given in the first 8 hours and the second half is given in the subsequent 16 hours. In children, maintenance fluid must also be given. This is normally dextrose – saline given as follows:

- 100ml per kg for the first 10 Kg.
- 50ml per kg for the next 10Kg:
- 20ml kg for 24 hours for each kilogram over 20kg body weight**.**

Investigations

Urine – Albumin Hb% PCV

Sugar

Blood – Urea Creatinine Sugar Electrolytes

Blood Grouping-

Burn wound care:- Method chosen

| Open method | Closed method |
|---|---|
| • Under IV Fortwin<br>• Would cleansing<br>• Application of Anti-microbial cream | • Under GA/IV Ketamine<br>• Wound cleaning<br>• Application of collagen membrane<br>• Time applied |

**MONITORING**

- Vital signs
- Urine output
- Drugs administered

**Follow up (From 2nd day onwards)**

- Vital signs –
- Nutrition - IV Oral
- Protein infusion (if any)
- Pain relief
- Ambulation of Patient
- Wound status

**First week (3rd – 7th day)**

- Nutrition - IV/Oral (Type – Liquid / Solid)
- Protein infusion (if any)
- Pain relief
- Surface culture –
- Wound status

**Second week**

- Nutrition – Type –
- Pain relief
- Surface culture
- Drugs administered
- Wound status

Further follow up

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# Group – I (Open Method)

| S. No | Name & Address | Age | Sex | IP No | Cause of Burns | Extent of Burns | Depth OfBurns | IVF after 24 hrs | Pain relief | Enteral feeding started | Wound Infection | Bacteriology | Wound Healing | During of Hospital Stay |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Durga | 25 | F | 1340709 | A | 40 | $I^o$ $II^o$ $III^o$ | + | P | D | ++ | P | P&D | 26 |
| 2 | Chitra | 22 | F | 1343994 | A | 36 | $I^o$ $II^o$ | - | B | D | + | P | G | 18 |
| 3 | Murugesan | 35 | M | 1344814 | S | 24 | $II^o$ $III^o$ | + | G | D | + | PM | P&D | 18 |
| 4 | Vijalakshmi | 21 | F | 1346943 | A | 20 | $I^o$ $II^o$ | - | B | D | + | PM | G | 17 |
| 5 | Thangarasu | 50 | M | 1346346 | A | 45 | $I^o$ $II^o$ | - | B | <2days | + | P | G | 12 |
| 6 | Narasimma | 30 | M | 1346800 | A | 50 | $I^o$ $II^o$ $III^o$ | + | P | D | ++ | PM | P&D | 45 |
| 7 | Kasthoori | 40 | F | 1347750 | S | 45 | $I^o$ $II^o$ $III^o$ | + | P | D | - | - | - | Died on the 3rd Day |
| 8 | Sathya | 23 | F | 1351759 | A | 15 | $I^o$ $II^o$ | + | G | <2days | + | K | G | 18 |
| 9 | Noornisha | 25 | F | 1354543 | A | 20 | $I^o$ $II^o$ $III^o$ | + | P | D | ++ | PM | P&D | 26 |
| 10 | Ayyasamy | 40 | M | 1356622 | A | 35 | $I^o$ $II^o$ $III^o$ | + | P | D | ++ | P | P&D | 33 |

| S. No | Name & Address | Age | Sex | IP No | Causes of Burns | Extent of Burns | Depth of Burns | IVF after 24 hours | Pain relief | Enteral feeding started | Wound infection | Bacteriology | Wound Healing | During of Hospital Stay |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11 | Mohamed | 45 | M | 1361732 | A | 35 | $I^o$ $II^o$ | - | G | D | + | E | G | 19 |
| 12 | Jeyabalan | 10 | M | 861417 | A | 12 | $I^o$ $II^o$ | - | G | D | + | K | G | 16 |
| 13 | Javahar | 10 | M | 861630 | A | 30 | $I^o$ $II^o$ $III^o$ | + | P | D | ++ | PM | P&D | 17 |
| 14 | Dharshini | 7 | F | 863432 | A | 15 | $I^o$ $II^o$ | - | G | <2days | + | P | G | 18 |
| 15 | Pooja | 4 | F | 865470 | A | 25 | $II^o$ $III^o$ | + | P | D | ++ | PM | P&D | 20 |
| 16 | Supriya | 12 | F | 876587 | A | 16 | $I^o$ $II^o$ | - | G | <2days | + | P | G | 15 |
| 17 | Gomathi | 40 | F | 1361736 | A | 36 | $I^o$ $II^o$ $III^o$ | + | P | D | ++ | PM | P&D | 30 |
| 18 | Sreedevi | 20 | F | 1371523 | S | 20 | $I^o$ $II^o$ | + | P | D | ++ | K | P&D | 20 |
| 19 | Thirumal | 28 | M | 1373061 | A | 15 | $I^o$ $II^o$ | - | G | <2days | + | E | G | 10 |
| 20 | Chandra | 23 | F | 1374312 | A | 30 | $I^o$ $II^o$ $III^o$ | + | P | D | ++ | K | P&D | 25 |

| | Name & Address | Age | Sex | IP No | Causes of Burns | Extent of Burns | Depth of Burns | IVF after 24 hours | Pain relief | Enteral feeding started | Wound infection | Bacter iology | Wound Healing | During of Hospital Stay |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **21** | **Vasuki** | **25** | **F** | **1400186** | **A** | **20** | **$I^o$ $II^o$** | **+** | **G** | **D** | **++** | **PM** | **P&D** | **16** |
| **22** | **Renuga** | **22** | **F** | **1396780** | **A** | **36** | **$I^o$ $II^o$** | **-** | **B** | **D** | **+** | **P** | **G** | **18** |
| **23** | **Manoharan** | **35** | **M** | **1353359** | **S** | **24** | **$II^o$ $III^o$** | **+** | **G** | **D** | **+** | **K** | **P&D** | **18** |
| **24** | **Rajakumari** | **20** | **F** | **1356161** | **A** | **30** | **$I^o$ $II^o$** | **-** | **G** | **D** | **+** | **PM** | **G** | **17** |
| **25** | **Louis** | **28** | **M** | **1367543** | **A** | **25** | **I II** | **-** | **B** | **<2days** | **+** | **K** | **G** | **12** |
| **26** | **Nagaraj** | **30** | **M** | **1405436** | **A** | **50** | **$I^o$ $II^o$ $III^o$** | **++** | **P** | **D** | **++** | **PM** | **P&D** | **45** |
| **27** | **Suresh kumar** | **23** | **F** | **1372589** | **S** | **45** | **$I^o$ $II^o$ $III^o$** | **+** | **P** | **D** | **++** | **PM** | **P&D** | **30** |
| **28** | **Sruthisree** | **10** | **F** | **876860** | **A** | **15** | **$I^o$ $II^o$** | **-** | **G** | **D** | **+** | **P** | **G** | **18** |
| **29** | **Madhavi** | **25** | **F** | **1398760** | **A** | **30** | **$I^o$ $II^o$ $III^o$** | **+** | **G** | **D** | **+** | **PM** | **P&D** | **19** |
| **30** | **Mathivanan** | **40** | **M** | **1407865** | **A** | **25** | **$I^o$ $II^o$** | **+** | **G** | **D** | **+** | **P** | **G** | **20** |

# Group – II (Collagen)

| S. No | Name & Address | Age | Sex | IP No | Causes of Burns | Extent of Burns | Depth of Burns | IVF after 24 hours | Pain relief | Enteral feeding started | Wound infection | Bacteriology | Wound Healing | During of Hospital Stay |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | manikandan | 32 | M | 1356780 | S | 45 | $II^o$ $III^o$ | + | G | D | ++ | K | P&D | 20 |
| 2 | Baskaran | 26 | M | 1413287 | A | 15 | $I^o$ $II^o$ | _ | E | <2days | + | P | G | 12 |
| 3 | Veerammal | 26 | F | 1406543 | A | 25 | $I^o$ $II^o$ | - | E | <2days | + | P | G | 12 |
| 4 | Suresh | 40 | M | 1402345 | A | 20 | $I^o$ $II^o$ | - | B | <2days | + | P | G | 13 |
| 5 | Maheswari | 28 | F | 1397684 | A | 20 | $I^o$ $II^o$ $III^o$ | + | G | D | + | E | G | 15 |
| 6 | Ponnammal | 45 | F | 1397564 | A | 18 | $I^o$ $II^o$ | - | E | <2days | + | K | G | 16 |
| 7 | Latha | 50 | F | 1408769 | S | 15 | $II^o$ $III^o$ | - | E | <2days | + | K | G | 14 |
| 8 | Arputham | 23 | F | 1398723 | A | 30 | $I^o$ $II^o$ $III^o$ | + | B | D | + | P | G | 20 |
| 9 | Mohan | 48 | M | 1389678 | A | 35 | $I^o$ $II^o$ | + | G | <2days | ++ | E | G | 15 |
| 10 | Saraswathi | 26 | F | 1398345 | A | 30 | $I^o$ $II^o$ $III^o$ | - | B | <2days | + | K | G | 20 |

| S. No | Name & Address | Age | Sex | IP No | Causes of Burns | Extent of Burns | Depth of Burns | IVF after 24 hours | Pain relief | Enteral feeding started | Wound infection | Bacter iology | Wound Healing | During of Hospital Stay |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11 | Meena | 3 | F | 894536 | A | 25 | $II^o$ $III^o$ | - | G | <2days | + | P | G | 16 |
| 12 | Ganesan | 7 | M | 886745 | A | 30 | $I^o$ $II^o$ $III^o$ | - | B | D | + | P | G | 18 |
| 13 | Manohar | 6 | M | 879675 | A | 15 | $I^o$ $II^o$ $III^o$ | - | E | <2days | + | K | G | 14 |
| 14 | Saranya | 8 | F | 885123 | A | 25 | $II^o$ $III^o$ | - | E | <2days | + | P | G | 16 |
| 15 | Muthu | 10 | M | 890698 | A | 15 | $II^o$ $III^o$ | - | B | D | + | K | G | 19 |
| 16 | Selvi | 13 | F | 870909 | A | 40 | $I^o$ $II^o$ $III^o$ | ++ | E | D | ++ | PM | P&D | 28 |
| 17 | Vasuki | 27 | F | 1421456 | A | 30 | $II^o$ $III^o$ | - | E | <2days | + | P | G | 17 |
| 18 | Veni | 25 | F | 1409845 | A | 25 | $I^o$ $II^o$ $III^o$ | - | B | <2days | + | E | G | 15 |
| 19 | Jeyanthi | 27 | F | 1405567 | A | 35 | $II^o$ $III^o$ | + | B | D | ++ | PM | P&D | 40 |
| 20 | Neela | 16 | F | 1407786 | S | 25 | $I^o$ $II^o$ | - | E | <2days | + | PM | G | 20 |

| S. No | Name & Address | Age | Sex | IP No | Causes of Burns | Extent of Burns | Depth of Burns | IVF after 24 hrs | Pain relief | Enteral feeding started | Wound infection | Bacteriology | Wound Healing | During of Hospital Stay |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 21 | Raman | 42 | M | 1411872 | S | 45 | $II^o$ $III^o$ | + | G | D | + | - | - | Died on 4th Day |
| 22 | Ramesh | 26 | M | 1400894 | A | 15 | $I^o$ $II^o$ | - | E | <2days | ++ | P | G | 12 |
| 23 | Sumathi | 26 | F | 1411672 | A | 25 | $I^o$ $II^o$ | - | E | <2days | + | P | G | 12 |
| 24 | Revathi | 40 | F | 1400443 | A | 20 | $I^o$ $II^o$ | - | B | <2days | + | P | G | 13 |
| 25 | chandran | 28 | M | 1411345 | A | 20 | $II^o$ $III^o$ | + | G | D | + | E | P&D | 20 |
| 26 | reka | 45 | F | 1411342 | A | 30 | $I^o$ $II^o$ | - | E | <2days | ++ | K | G | 16 |
| 27 | Meena | 50 | F | 1409231 | S | 15 | $II^o$ $III^o$ | - | G | <2days | + | K | G | 14 |
| 28 | Prathnisha | 23 | F | 1400098 | A | 30 | $I^o$ $II^o$ $III^o$ | + | B | <2days | + | P | G | 20 |
| 29 | Pandiyan | 45 | M | 1400556 | A | 25 | $II^o$ $III^o$ | - | G | <2days | + | E | G | 19 |
| 30 | Dharmamba | 26 | F | 1412314 | A | 28 | $II^o$ $III^o$ | + | B | D | + | K | G | 20 |

**Sex**

**M-Male**

**F-Female**

**Causes**

**A-Accidental**

**S-suicidal**

**H-Homicidal**

**Pain relief**

**E-Excellent**

**B-Better**

**G-Good**

**IVF after 24 hrs**

**(-)-Not needed**

**(+)-Up to 2 days**

**(++)>2 days**

**Bacteriology**

**P-Proteus**

**PM-Pseudomonas**

**K-Klebsiella**

**E-Ecoli**

**Wound Healing**

**G-Good**

**P&D-Poor &delayed<2 days**

**Enteral feeding started**

**D-Delayed**

## CLASSIFICATION ACCORDING TO BURN DEPTH

Classification according to burn depth—clinically can be classified broadly into

**Superficial burns**
- Can heal on their own by epithelialization from viable epidermal elements present in the spared dermis

**Deep burns**
- Do not heal on their own and therefore require skin grafting

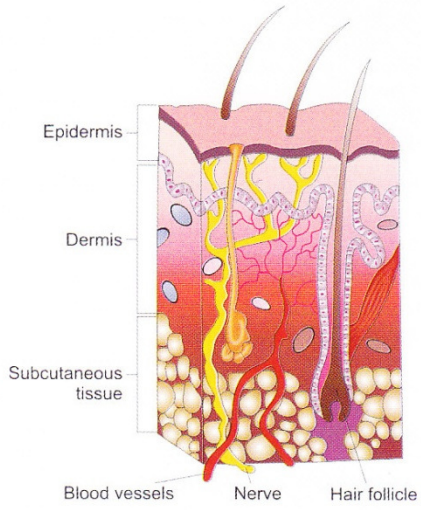



**Fig. 1.26A:** Anatomy of skin

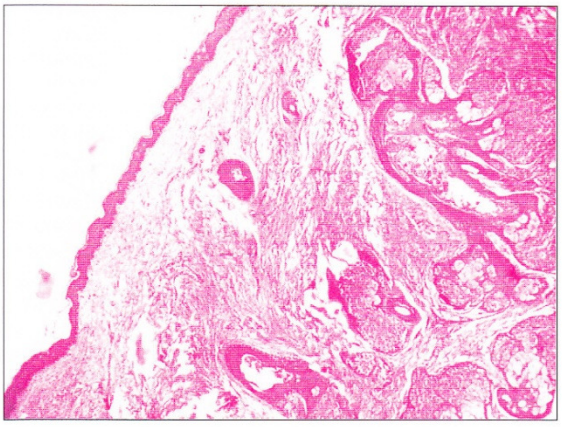


**Fig. 1.26B:** Histopathological picture of normal skin

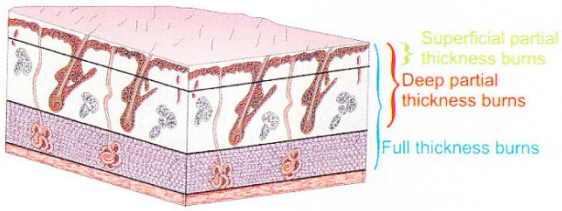



**Fig. 1.27:** Different degrees of burn as per the depth of involvement of skin—superficial partial thickness burns involving epidermis and upper papillary dermis; deep partial thickness burns involving epidermis, papillary and reticular dermis; full thickness burns involving the entire thickness of epidermis and dermis till subcutaneous fat

SECOND AND THIRD DEGREE BURNS – COLLAGEN APPLIED

CLOSED DRESSING AFTER COLLAGEN APPLICATION

FIRST AND SECOND DEGREE BURNS – COLLAGEN APPLIED

CLOSED DRESSING AFTER COLLAGEN APPLICATION

PAEDIATRIC BURNS SECOND AND  THIRD DEGREE

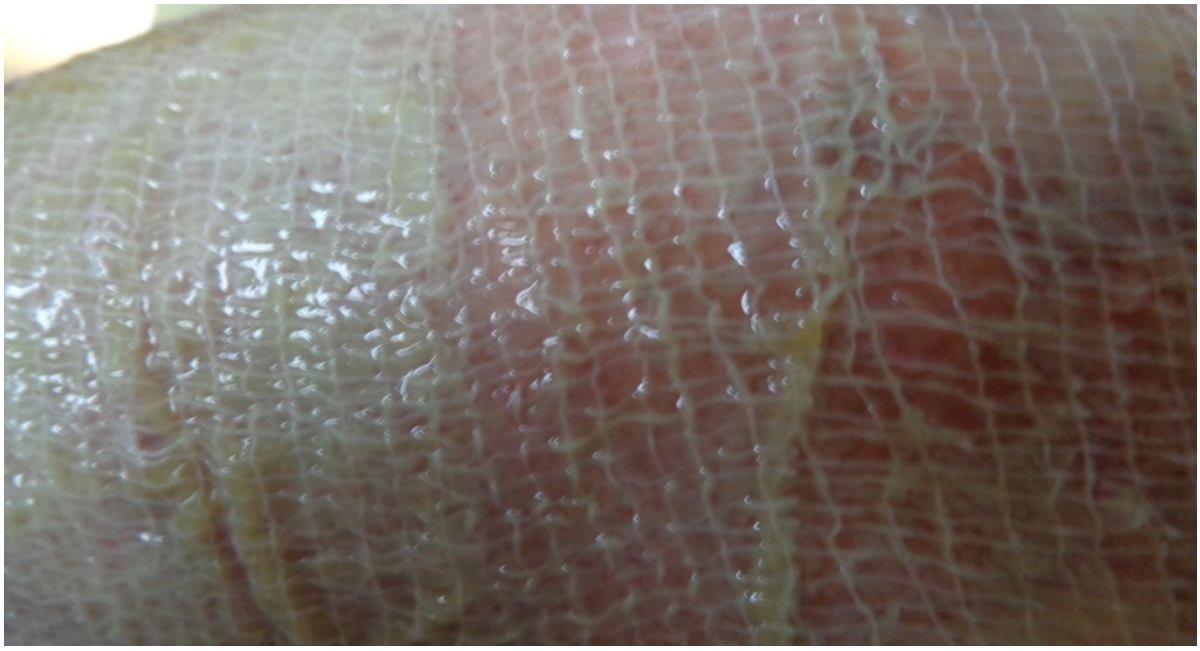
FIRST AND SECOND DEGREE BURNS – OPEN METHOD

SECOND AND THIRD DEGREE BURNS – OPEN METHOD

RYLE,S TUBE FEEDING

SECOND AND DEGREE BURNS – COLLAGEN APPLIED

# COLLAGEN SHEET



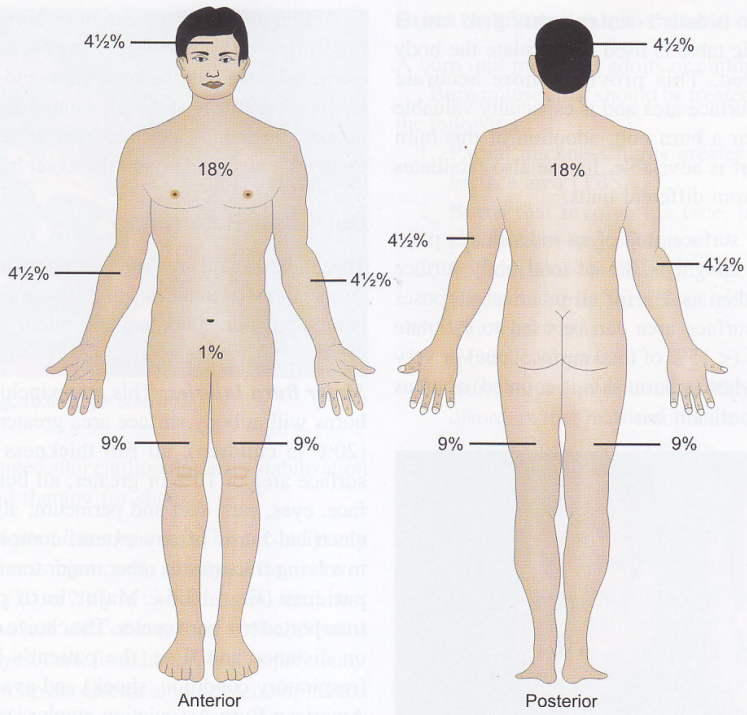
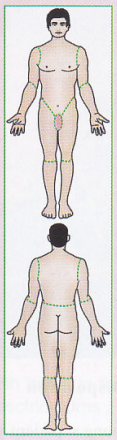



**Fig. 10.4:** Wallace's Rule of 9

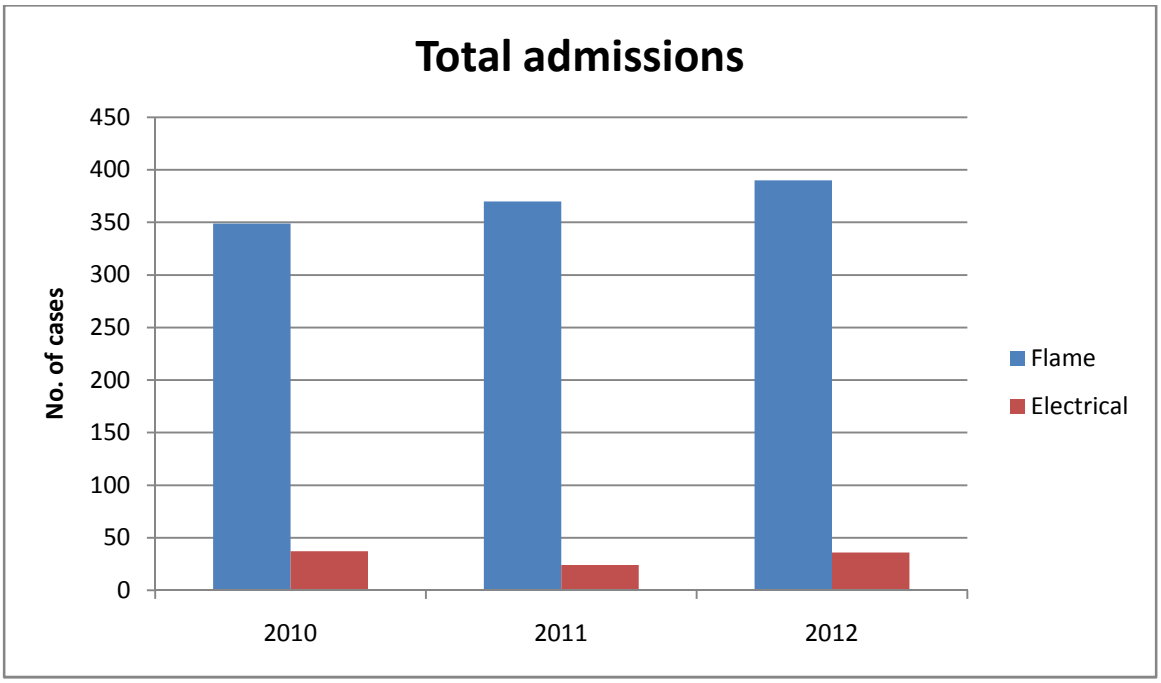
**Table 10.3:** Lund and Browder's chart for estimating area of burns

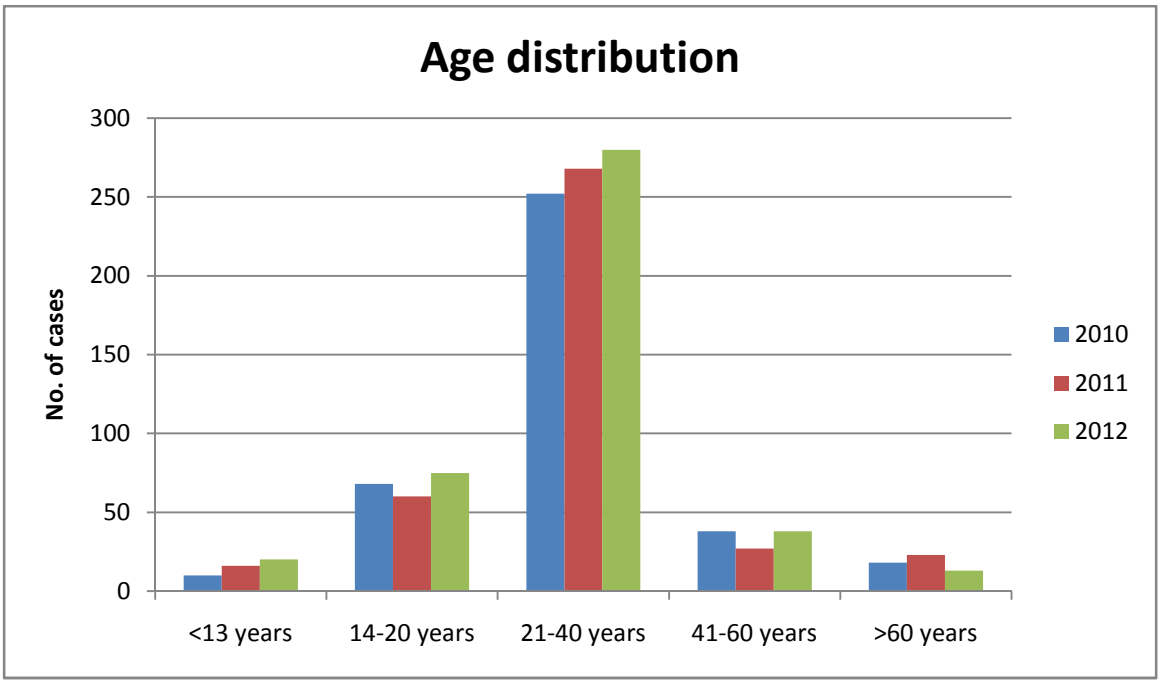
| *Area* | *Birth to1 year* | *1 to 4 years* | *5 to 9 years* | *10 to 14 years* | *15 years* | *Adult* | *2nd** | *3rd** | *TBSA* |
|---|---|---|---|---|---|---|---|---|---|
| Head | 19 | 17 | 13 | 11 | 9 | 7 | | | |
| Neck | 2 | 2 | 2 | 2 | 2 | 2 | | | |
| Anterior trunk | 13 | 13 | 13 | 13 | 13 | 13 | | | |
| Posterior trunk | 13 | 13 | 13 | 13 | 13 | 13 | | | |
| Right buttock | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | | | |
| Left buttock | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | | | |
| Genitalia | 1 | 1 | 1 | 1 | 1 | 1 | | | |
| Right upper arm | 4 | 4 | 4 | 4 | 4 | 4 | | | |
| Left upper arm | 4 | 4 | 4 | 4 | 4 | 4 | | | |
| Right lower arm | 3 | 3 | 3 | 3 | 3 | 3 | | | |
| Left lower arm | 3 | 3 | 3 | 3 | 3 | 3 | | | |
| Right hand | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | | | |
| Left hand | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | | | |
| Right thigh | 5.5 | 6.5 | 8 | 8.5 | 9 | 9.5 | | | |
| Left thigh | 5.5 | 6.5 | 8 | 8.5 | 9 | 9.5 | | | |
| Right leg | 5 | 5 | 5.5 | 6 | 6.5 | 7 | | | |
| Left leg | 5 | 5 | 5.5 | 6 | 6.5 | 7 | | | |
| Right foot | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | | | |
| Left foot | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | | | |
| Total: | 100 | 100 | 100 | 100 | 100 | 100 | | | |

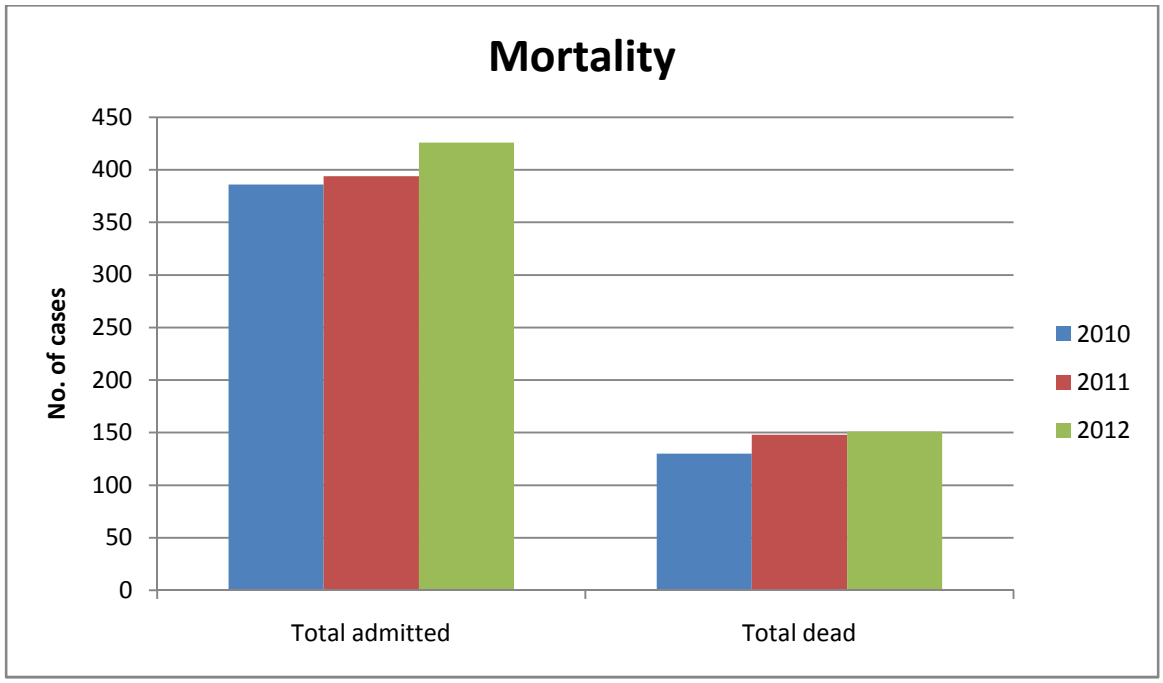


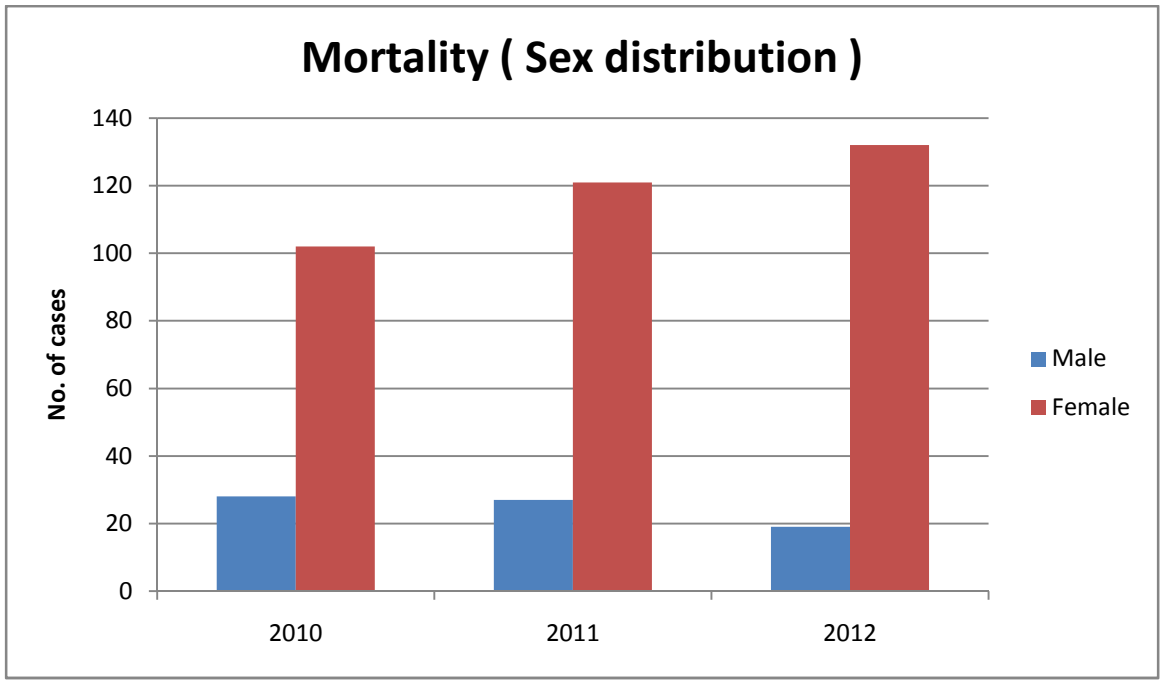
The figures can be colored in red for full-thickness burns (3rd*) and blue for partial-thickness burns (2rd*). TBSA – Total body surface area.

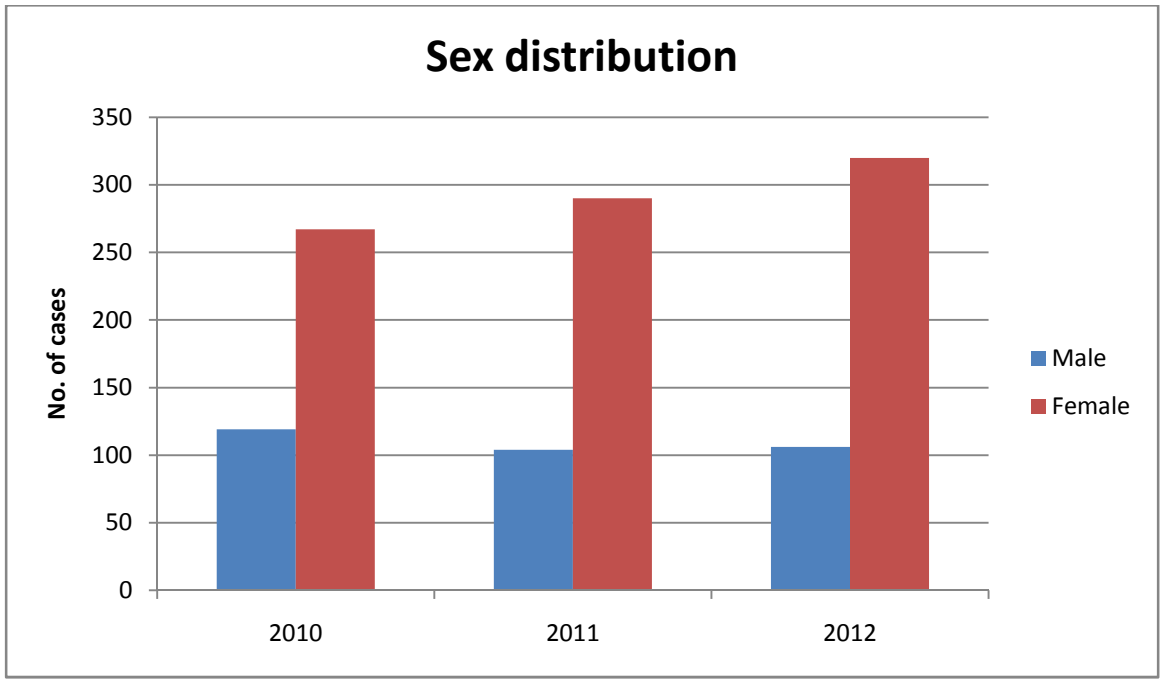
FIRST AND SECOND DEGREE BURNS – OPEN METHOD

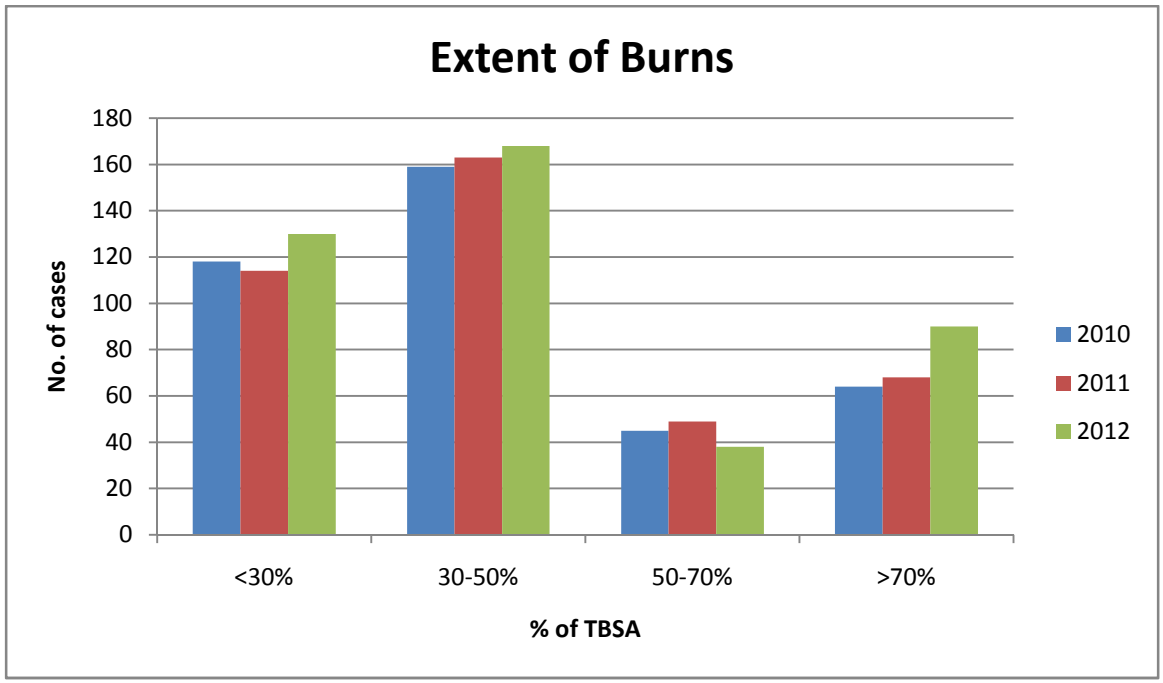

Total admissions
No. of cases
450
400
350
300
250
200
150
100
50
0
2010
2011
2012
Flame
Electrical


Age distribution
No. of cases
300
250
200
150
100
50
0
<13 years
14-20 years
21-40 years
41-60 years
>60 years
2010
2011
2012


Mortality
450
400
350
300
250
200
150
100
50
0
No. of cases
Total admitted
Total dead
2010
2011
2012


Mortality ( Sex distribution )
140
120
100
80
60
40
20
0
No. of cases
2010
2011
2012
Male
Female


Sex distribution
350
300
250
200
150
100
50
0
No. of cases
2010
2011
2012
Male
Female


Extent of Burns
180
160
140
120
100
80
60
40
20
0
No. of cases
<30%
30-50%
50-70%
>70%
% of TBSA
2010
2011
2012

# THANJAVUR MEDICAL COLLEGE

THANJAVUR, TAMIL NADU, INDIA – 613 004

(Affiliated to the T.N. Dr. MGR Medical University, Chennai)

**ETHICAL COMMITTEE**

# CERTIFICATE

| | | |
|---|---|---|
| Name of the candidate | : | **Dr. S.MANIMARAN** |
| Course | : | M.S (General Surgery) |
| Period of Study | : | 2010-2013 |
| College | : | THANJAVUR MEDICAL COLLEGE |
| Dissertation Topic | : | MANAGEMENT OF BURNS WOUND COMPARATIVE ANALYSIS OPEN EXPOSURE METHOD VS CLOSED COLLAGEN METHOD |

The Ethical Committee, Thanjavur Medical College has decided to inform that your Dissertation Topic is accepted and you are permitted to proceed with the above study.

Thanjavur Secretary

Date: Ethical Committee