THERMAL INJURIES

Exposure to Heat

Local Effects

- **Burns –** Due to application of dry heat
- **Scalds –** Due to application of moist heat

Definition: BURNS

- Injuries produced by application of dry heat by flame, radiant heat or some heated solid substance like metal or glass
- Burn Injuries produced by
  - Friction
  - Lightening
  - Electricity
  - UV and Infrared rays
  - X rays
  - Corrosives

X ray burns

- Mere redness to dermatitis
- Shedding of hair and epidermis
- Pigmentation of surrounding skin
- Fingernails show degenerative changes and wart like growths
- Severe exposure – vesicles or pustules – form sloughing ulcers – slowly heal
- Radial shape scar with surrounding pigmentation

Chemical rays and Corrosives

- UV rays
  - Undue exposure to Sun
  - Erythema of exposed part
  - Vesication
- Infrared rays
  - Necrosis and toughening of tissue exposed
- Corrosives
  - Distinctive stains
  - Eschars – moist and soft, ready slough away
  - No red line of demarction
  - Hair are not scorched
  - No vesication

Classification…

- Dupuytrens Classification:
  - First degree - Erythema
  - Second degree - Vesication with blister formation
  - Third degree - Destruction of superficial skin
  - Forth degree - Destruction of whole skin (dermis)
  - Fifth degree - Destruction of fascia and muscles
  - Sixth degree - Charring involving vessels, nerve, bones

Classification

- Wilson's Classification
  - Epidermal (Dupuytren's 1st and 2nd degree)
  - Dermo-epidermal (Dupuytren's 3rd and 4th degree)
  - Deep (Dupuytren's 5th and 6th degree)
- Hebra's Classification:
  - Three degrees (Same as Wilson's)

Patho-pysiology

- Local tissue response
- Systemic response to burn injury.

Local tissue response

- Damage to skin from thermal injury cause tissue changes know as zone of injury.
- If the heat is severe, a zone of coagulation is formed, in this area protein has been coagulated and the damage is irreversible.

Local tissue response

- Therefore, blood vessels are damage, resulting in ↓perfusion.

Zone of Statis

- Poor blood flow and tissue edema will cause risk for death over a few hours or days.
- Further necrosis can happen, because other factors e.g dehydration and infection.
- Due to these wound have to be clean/care, hydration and prevention of infection are essential to limit further destruction.

Local tissue response

- **Zone of hyperemia** or inflammation is at the outer edge of the burn.
- Here blood flow is ↑because of vasodilation.
- Vasodilation because of the release of vasoactive substances.
- ↑blood flow brings leukocytes and nutrients to promote wound healing.

Facts to be established……

- Identification of the person
- Whether victim was alive at time of fire
- The cause of death
- The manner of death
- Any other factor that contributed to either cause of fire or death of the person, e.g. drugs or alcohol

Effects of burns……

- Intensity of heat applied
- Duration of exposure

} 44^0C for 5-6 hours
} 65^0C for 2 sec

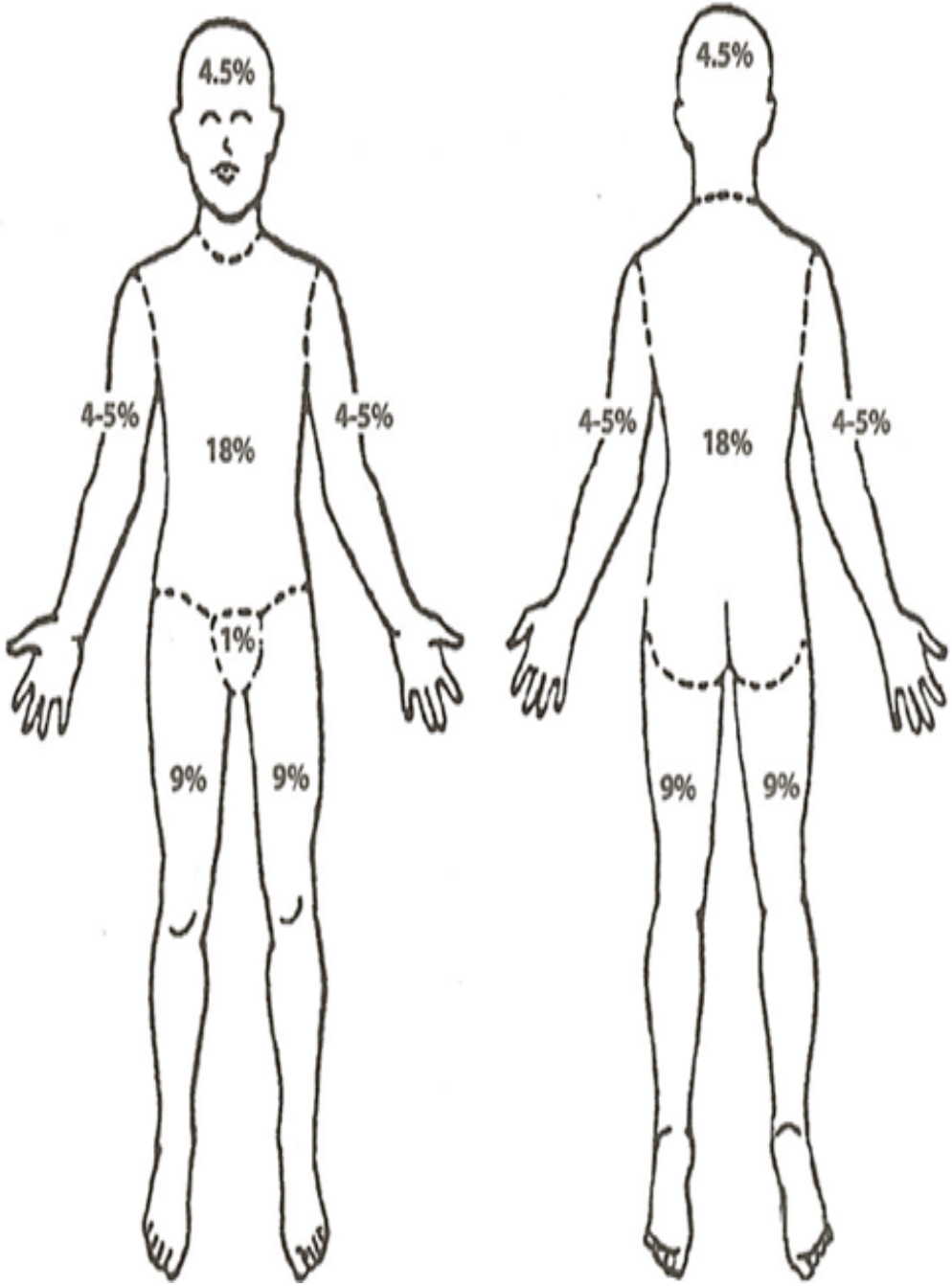
- Extent of Total Burnt Surface Area

(WALLACE'S RULE OF NINE)

- Site of burns
  - Burns on head & neck, trunk or anterior abdominal wall are more dangerous
- Age - Children are more susceptible
- Sex - Female are more susceptible

RULE OF NINE

- 9% each
  - Head and neck
  - Each for upper limb
  - Front of chest
  - Back of chest
  - Front of abdomen
  - Back of chest
  - Front of lower limb
  - Back of lower limb
- 1 % for perineum



Lund and Browder

- More precise method of estimating
- Recognizes that the percentage of BSA of various anatomic parts.
- By dividing the body into very small areas and providing an estimate of proportion of BSA accounted for by such body parts
- Includes, a table indicating the adjustment for different ages
- Head and trunk represent larger proportions of body surface in children.

RELATIVE PERCENTAGES OF AREAS AFFECTED BY GROWTH

AREA	AGE 10	15	ADULT
A $\frac{1}{2}$ OF HEAD	$5\frac{1}{2}$	$4\frac{1}{2}$	$3\frac{1}{2}$
B $\frac{1}{2}$ OF ONE THIGH	$4\frac{1}{4}$	$4\frac{1}{2}$	$4\frac{3}{4}$
C $\frac{1}{2}$ OF ONE LEG	3	$3\frac{1}{4}$	$3\frac{1}{2}$

Lund and Browder chart

Age in years	0	1	5	10	15	Adult
A-head (back or front)	9½	8½	6½	5½	4½	3½
B-1 thigh (back or front)	2¾	3¼	4	4¼	4½	4¾
C-1 leg (back or front)	2½	2½	2¾	3	3¼	3½

Complications

Early

- Hypovolemia
- Fluid overload
- Renal dysfunction
- Hemoglobinuria
- Stress gastroduodenal ulcers
- Pulmonary dysfunction
- Local / systemic sepsis

Complications

Late

- Scarring – hypertrophic, keloid
- Contractures – limbs, neck
- Disfigurement
- Functional disability
- Posttraumatic stress

Cause of death….

- Immediate to within few hours
  - Primary shock- Neurogenic shock - due to pain
  - Asphyxia – inhalation of smoke, suffocation
- Within first 48 hours
  - Secondary shock – loss of fluid from burnt region
- 3-4 days
  - Toxaemia – absorption of various metabolite from burnt region
- 4-5 days and later
  - Sepsis, Gastric ulceration, Oedema of glottis, acute renal failure, Gangrene, Pulmonary embolism, ARDS, tetanus
- Years after….
  - Malignant transformation of burn scar (Marjolin's ulcer)

Age of burns

Erythema / Redness	immediately
Vesication	2 -3 hours
Exudation dry up	12-24 hours
Dry crust formation	48 – 72 hours
Pus	2 - 3 days
Superficial slough separates	1 week
Deep slough separates	2 weeks
Granulation tissue - Scar form	weeks - months

Autopsy findings…..

- Remnants of clothing
- Smell of inflammable agent
- External finding
  - Reddening, Blister formation
  - Blackening, Charring and roasting
  - Singeing and burning of hair
  - Blood tinged froth
  - ‘HEAT RUPTURES’
  - ‘Pugilistic attitude’
  - Heat fractures

HEAT RUPTURES

- Area of severe burning
- Over fleshy area like calves and thighs
- Splits due to contraction of the heated and coagulated tissue
- Resemble like lacerated wound except that
  - Area of distribution
  - No infiltration of blood in surrounding tissue
  - Absence of blood clot
  - Presence of intact blood vessels and nerve stretching across the floor of the ruptures

Pugilistic attitude

- Boxing, fencing, or defense attitude
- Body exposed to great heat
- Legs flexed at hips and knees, arms flexed at elbows and wrists, fingers hooked like claws
- Stiffening due to coagulation of proteins of muscles
- Flexor muscles are bulkier than extensors
- Both in person alive or dead at time of burning

Heat fractures

- Skull fractures – common where skull is severely burnt
  - Two types:
    - Intracranial increase of steam pressure – separation of un-united sutures, fracture with gapping margins
    - Fracture due to rapid drying of the bone with contraction – involves only outer table of the bone. Several line radiating from common center
- Curved fractures in bones of extremities

Internal findings

- Internal organs congested
- Presence of "HEAT HEMATOMA"
  - Resemble Extradural hemorrhage
  - Actually a artefact
  - Head is exposed to intense heat
  - Clot is Chocolate brown in colour
  - Clot is soft, friable and honey-comb appearance
- Tongue , larynx, trachea and bronchi inflamed and contains soot mixed with mucus
- Presence of CO in blood – bright pink appearance of blood

Antemortem Burns

- Presence of soot in trachea
- Thermal injury in Respiratory tract
- Line of redness (Vital reaction)
- Vesication
- Elevated CO in blood
- Presence of other toxic gases in blood
- Histopathological examination