

Thermal Deaths: those deaths which result from the effects of systemic &/or localised exposure to excessive heat & cold.

Burns: an injury which is caused by application of heat / chemical substances to the external / internal surfaces of the body, which causes destruction of tissues.

→ minimum temperature for producing a burn =  $44^{\circ}\text{C}$  for 5-6 hrs exposure.

### Types of Burns:

1] Highly heated solid body / molten metal: blister & reddening corresponding in size & shape to the material used.

→ epidermis: blackened, dry, wrinkled.

→ hair may be singed / distorted.

2] Flame burns: may / may not produce vesication.

→ singeing of hair & blackening of skin are always present.

3] Kerosene oil / Petrol Burns: usually severe  $\Rightarrow$  sooty blackening of parts with characteristic odour.

4] Explosion in coal mines / Gun powder: extensive usually.

→ blackening & tattooing

5] X-ray & Radium burns: vary from redness of skin to dermatitis, + shedding of hair + pigmentation of surrounding skin.

6] UV rays Burns: erythema or acute eczematous dermatitis.

7] Radiant heat burns

8] Microwave burns: well-demarcated, full thickness burns (without charring).

9] Burns from corrosive substances: ulcerated patches (no blisters / singeing of hair / red line of demarcation).

10] Electrical burns.

# Degrees of Burns:

## I] Dupuytren's Classification:

1st degree	Reddening / erythema
2nd degree	Blistering (bulla formation)
3rd degree	Destruction of epidermis
4th degree	Destruction of whole dermis
5th degree	Destruction of muscles (painless due to destruction of nerve fibres)
6th degree	Complete charring (burn reaches the bone $\Rightarrow$ painless)

## II] Wilson & Hebra Classification:

Dupuytren	Hebra	Wilson
1st degree	1°	Epidermal
2nd degree		
3rd degree	2°	Desmo-epidermal
4th degree		
5th degree	3°	Deep
6th degree		

# Factors Affecting Effect of Burns:

## 1] Degree of heat:

→ ↑ heat ⇒ ↑ damage.

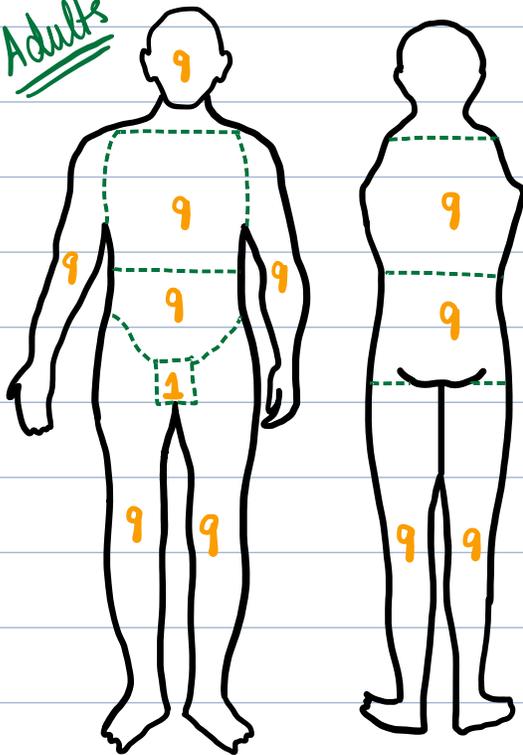
→ for cremation ⇒ human body has to be incinerated for 90 minutes at 1000°C.

## 2] Duration of exposure: ↑ time of exposure ⇒ ↑ damage.

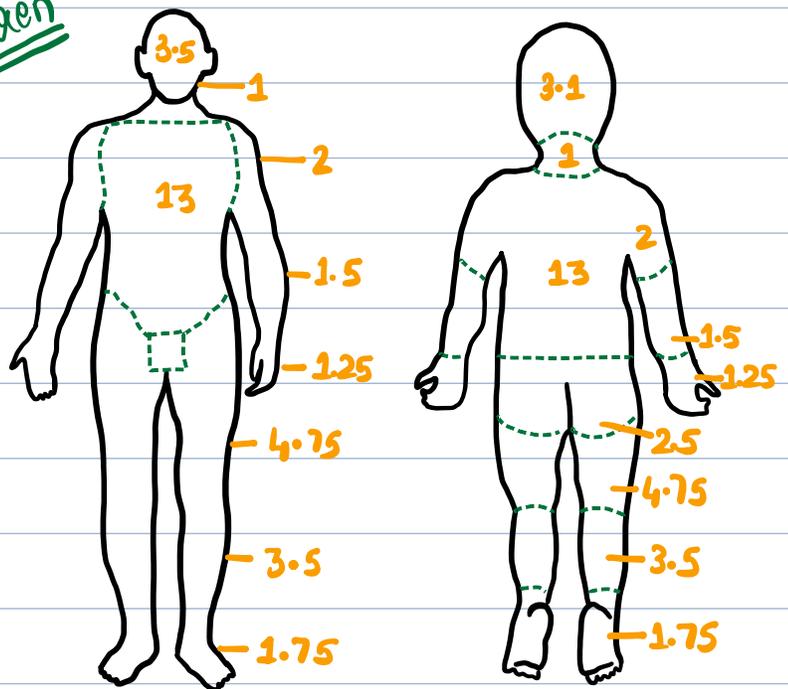
## 3] Extent / Surface area involved:

\* Wallace's rule of Nine: palmar surface of patient's hand ≈ 1% BSA.

Adults



Children



4] Site: burns of head / neck / trunk / anterior abdominal wall are more dangerous.

5] Age: children are more susceptible.

6] Sex: Women are more susceptible.

Lund & Bowdler Chart for Estimation of % of BSA Burned in Children:

Area of body	1-4 years	5-9 years	10-14 years	Adult
Head & neck	19 %	15 %	14 %	9 %
Front of trunk	16 %	16 %	16 %	18 %
Back of trunk	16 %	16 %	16 %	18 %
Upper limb	19 %	19 %	19 %	18 %
Lower limb	30 %	34 %	34 %	36 %
Genitalia	0	0	1 %	1 %

Causes of Death:

- 1] Primary (neurogenic) shock due to pain.
- 2] within 48 hours  $\Rightarrow$  Secondary shock due to fluid loss from burns.
- 3] Inhalation of CO is smoke, oxygen deprivation, free radicals.
- 4] Toxaemia  $\Rightarrow$  due to absorption of metabolites from burnt tissues upto 3-4 days.
- 5] Sepsis (4-5 days).
- 6] Biochemical disturbances (eg: hypokalaemia)  $\Rightarrow$  secondary to fluid loss.
- 7] Acute renal failure (3-4 days)
- 8] GI disturbances  $\Rightarrow$  Peptic ulceration / Dilation of stomach / Haemorrhage into intestines.
- 9] Oedema of glottis & pulmonary oedema (due to inhalation of smoke containing CO, CO<sub>2</sub>).
- 10] Injuries (while attempting to escape).
- 11] Pyaemia / gangrene / tetanus / etc.
- 12] Fat embolism.
- 13] Pulmonary embolism (due to thrombosis of veins of legs due to tissue damage & immobility).
- 14] Marjolin's ulcer (malignant transformation of a burn scar)  $\Rightarrow$  years later.

## PM Appearances:

- clothes should be removed & examined for kerosene, petrol, etc.
- heat rigor in muscles.
- Decomposition: accelerated (if burns are limited to body surface)  
reduced (in severe burns)
- Hair: singed / completely burnt.
  - colour of light-coloured hair changes on exposure to heat (no change in colour of black hair).
- face: swollen, distorted
- tongue protrudes (due to contraction of tissues of neck & face)
- froth may appear at mouth & nostrils (due to pulmonary oedema).  
(indicates antemortem burn)
- Hands & feet: skin detaches as glove (including fingernails). ⇒ degloving.
- Burnt areas ⇒ reddened & blistered / charred.
- burns may be absent in - gums      - armpits      - portions of body where clothing was tight.

Pugilistic attitude [Boxing/fencing/defence Attitude]: Posture of a body which has been exposed to great heat. (Antemortem / postmortem)

- legs are flexed at hips & knees.
  - arms are flexed at elbows & wrists.
  - head slightly extended.
  - all fingers are hooked like claws.
  - contraction of paraspinal muscles ⇒ marked opisthotonus. (this stiffening is due to coagulation of proteins of the muscles & dehydration)
- } held out in front of the body } since flexors are muscles are bulkier ∴ affected more.

Heat Ruptures: severe burning / charring → skin contracts → heat ruptures

- these splits generally occur over fleshy areas of the body
- may resemble lacerations.

Flash Burns: variant of flame burns

→ occur due to ignition / explosion of gases / fine particulate material

→ obesity & clothes contribute to a faster & more complete destruction of a body in fire.

Heat Haematoma: occurs when the head has been exposed to intense heat, sufficient to cause charring of the skull

→ appearance of extradural haemorrhage.

→ soft, friable clot of light chocolate colour & may be pink (if blood contains CO).

→ clot has a **honeycomb appearance** due to bubbles of steam produced by heat.

→ adjacent brain shows hardening & discolouration from the heat.

→ most common site: parietotemporal region.

Thermal fractures of the skull: Mechanisms -

i) Intracranial increase of steam pressure causes separation of ununited sutures ⇒ fractures with gaping defects & widely separated bony margins.

ii) Fracture occurs due to rapid drying of the bone with contraction & only involves outer table of the skull.

CO levels: in death due to burns ⇒ CO level  $> 10\%$  (may reach 70-80%).  
→ blood is cherry red (may change to brownish due to heat).

Death from suffocation: aspirated blackish coal particles are seen in nose, mouth, larynx, trachea, bronchi, oesophagus, stomach.

→ blood is cherry red.

- Presence of carbon particles in terminal bronchioles on histological examination ⇒ **absolute proof of life during the fire (Antemortem).**
- poisonous gases like cyanide & oxides of nitrogen are produced (due to burning of plastic & synthetic material) ⇒ inhalation injury of lungs.
  - pulmonary oedema
  - alveolar collapse
  - broncho-ciliary injury.
- interior of larynx, trachea, bronchi may be thickened & blanched or reddened & cells become swollen, ballooned.
- mucosa of air passages is shed into the lumen of the viscera
- sometimes: inhalation of smoke → vomiting → inhalation of vomitus → vomitus found in smaller bronchi.

**Viscera:** internal organs are usually well preserved (even in cases of severe external charring) ⇒ due to high water content.

- haemocoelom present.
- tissue oedema & excess of fluid in serous cavities.
- **Brain:**
  - shrunken, firm
  - yellow to light-brown
  - flattening of gyri, obliteration of sulci.
- **Lungs:**
  - congested, marked oedema
  - heavy, airless, consolidated
  - necrosis of alveolar epithelium
  - signs of infection & inflammation in delayed deaths.
- petechial haemorrhages in pleurae, pericardium, endocardium.
- heart is filled with clotted blood.
- occasionally ⇒ Stress ulcers (Curling ulcers) are produced in the 1st part of duodenum
- liver: cloudy swelling / necrosis
- kidneys: cloudy swelling / capillary thrombosis / infarction.

	Antemortem Burns	Postmortem Burns
Line of redness	Present.	Absent.
Blisters	Contains serous fluid with proteins & chlorides. Base: red & inflamed.	Contains air & thin clear fluid. Base: dry, hard yellow.
Vital reaction	Marked cellular exudation & reactive changes in tissue cells present.	Absent.
Enzymes	Peripheral zone of burn shows increase in enzyme reaction.	Peripheral zone does not show increase in enzyme reaction.

## Circumstances of Death:

→ In CO inhalation: severe muscular incoordination, weakness, confusion → victim is unable to escape → death due to asphyxia → body is burnt after death.

1) Accident: in kitchen / factories / electrical short circuits / manufacturing with fireworks / faulty heat appliances or electrical wiring / leakage of cooking gas / etc.

2) suicide: women commit suicide by pouring kerosene on their body before setting fire to themselves.

→ suicidal burning as a mode of public protest.

3) Homicide: rare.

BURNS	Dry Heat	Moist Heat	Chemicals
Cause	Flame, heated solid body, X-rays.	Steam or liquid above 60°C.	Corrosive chemicals.
Site	At & above the site of contact.	At & below the site of contact.	At & below the site of contact.
Splashing Skin	Absent.	Present.	Present.
Vesicles	Dry & wrinkled, may be charred.	Sodden & bleached.	May be destroyed.
Red line	At the circumference of burnt area.	Over the burnt area.	Very rare.
Colour	Present.	Present.	Absent.
Charring	Black.	Bleached.	Distinctive.
Singeing	Present.	Absent.	May be present.
Ulceration	Present.	Absent.	Absent.
Scar	Absent.	Absent.	Present.
Clothes	Thick & contracted.	Thin & less contracted.	Thick & contracted.
	Burnt.	Wet; not burnt.	May be burnt; show characteristic stains.

Scalds: an injury which results from the application of liquid above 60°C or from steam.

- destruction does not extend as deeply as in burns.
- redness appears immediately, blistering occurs in a few minutes.
- blisters have a hyperaemic zone around them.
- reddening & swelling of the papillae in the floor of the blister.

- blister fluid contains white & red cells.
- soddening present.
- bleaching present.
- hair singeing absent.
- injury is limited to the area of contact & is more severe at the point of initial contact.
- scalding can occur through clothing.
- sharply demarcated edge
- if inflammable fluids are used ⇒ signs of trickling of the burning fluid will be present.
- death: due to shock, fluid & electrolyte disturbance & secondary infection.

### Degrees of Scalds:

- 1] Erythema by vasoparalysis.
- 2] Blister formation due to increased permeability of the capillaries.
- 3] Necrosis of the dermis.

### Occurrence:

- usually accidental ⇒ due to bursting of hot water bottles / boilers  
⇒ splashing of fluid from cooking utensils.
- suicide is rare.
- boiling water may be thrown with intent to injury.

# Electrical Injuries:

ISHITA  
KANODIA

- alternating current is 4-5 times as dangerous as an equal voltage of direct current.
- electrocution is rare at < 100 volts.
- death occurs at > 200 volts.
- death is more likely to occur if the brain stem or heart are in the direct path of the current.
- severity is directly proportional to the duration of current flow.
- For electrical shock to occur ⇒ there must be contact by the body with both a positive & negative pole or the earth.
- Dry skin offers high resistance

## Electrical Mark (Joule Burn): found at the point of entry of current.

specific & diagnostic of contact with electricity

- endogenous thermal burn due to heat generated in the body from electricity.
  - round/oval
  - 1-3 cm in diameter
  - shallow craters
  - Ridge of skin about 1-3 mm high around part/whole of circumference.
  - crater floor is lined by pale flattened skin.
  - charring (on prolonged contact)
  - areola of blanched skin is seen at the periphery of the electric mark ⇒ pathognomonic of electrical damage.
  - hyperaemic border outside the blanching.
  - histologically ⇒ coagulation of the dermis  
⇒ separation of epidermis

## Flash / Spark Burns: (exogenous burn)

→ produced in high voltage (industrial) currents.

Crocodile skin: Keratin (in skin) melts over multiple small areas.

→ on cooling ⇒ molten keratin over these areas fuses into multiple hard brownish nodules.

Arc Eye: superficial & painful keratitis

- intense bilateral lacrimation
- blepharospasm
- photophobia.

→ resolves spontaneously within 36 hrs.

Electric Exit Mark: appears where the body was earthed/grounded.

→ more damage of tissues than at entry mark.

→ often seen as splits.

## PM Appearances:

I] External: examination of scene is very important.

- rigor mortis appears early
- postmortem lividity is well-developed
- eyes: congested, dilated pupils
- face: pale
- seminal ejaculation: due to contraction of seminal vesicles caused by electrical flow
- high tension electrocutions: - charring of the body  
- amputation of extremities.

## II] Internal:

- Congestion of all internal organs
- Brain: irregular tears & fissures
- Petechial haemorrhages: along the line of current

### i) Muscles & Tendons:

- Zenker's degeneration: of skeletal muscles in the path of current.
  - severe glassy/waxy hyaline degeneration of skeletal muscles.
  - muscles appear pale & friable.
- myoglobin is released into circulation.

### ii) Bones & Joints:

- Bone pearls/Waxy droppings: seen in high voltage currents.
  - heat generated → melts calcium phosphate in bone → seen radiologically as typical round density foci
- necrosis of bone
- fractures: generally hair thin (microfractures) ⇒ missed on X-rays often.
  - irregular zigzag course (osseous schisis).
- Electrical injury of skull ⇒ occurs due to arcing
  - ⇒ skull split open
  - ⇒ orbital contents extruded from eye sockets
- Current pearls: small balls of molten metal derived from metal of the contacting electrode (present deep in the tissue).

### iii) Heart: auricles dilated.

- petechial haemorrhage & ecchymoses on endocardium, pericardium, myocardium.

### iv) Vascular: microscopic lesions in media.

- massive coagulation necrosis of entire vessel wall.
- tissue edema.

iv) Kidney & Urine: lower nephron nephrosis (due to myoglobin entering nephrons).

→ myoglobinuria

v) abortion in pregnant females.

## Cause of Death:

1] Limb-to-Head Circuit: involves brain stem & upper cervical cord.

→ paralysis of medullary (respiratory) centres.

2] Limb-to-Limb Circuit: ventricular fibrillation or cardiac arrest.

3] High voltage shocks: respiratory arrest.

Judicial Electrocution: death penalty ⇒ carried out in the electric chair in some states in the U.S.A.

→ 1 cap-like electrode is put on the shaven scalp which is moistened with a conducting paste.

→ other electrode: right lower leg.

→ Current: 2000 volts, 7 amperes ⇒ passed for 1 minute.

→ After tetanic spasm & loss of consciousness ⇒ same current is passed again for 1 minute.