Chapter 17: HEAT, COLD & ELECTRICAL TRAUMA

Introduction: Heat, cold and electricity are some of the 'physical agents' that can **cause non-kinetic injuries to the body**.

Injury caused by heat:

Heat Sources:

1-Dry: known as "**burn**"

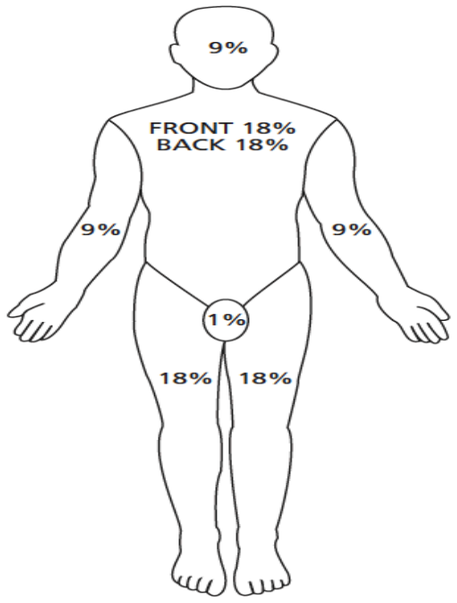
2- Wet or moist: known as "**scalding**" e.g. from hot water, steam and other hot liquids.

1. **Burns**: Can be classified by their **severity** (degree of burn injury and depth of tissue burned) and **extent** (burn area).

Severity of burn	1st degree	**Erythema and blistering (vesiculation)**
	2nd degree	Burning of **the full-thickness** of the epidermis and exposure of the dermis
	3rd degree	Destruction down **to subdermal tissues, sometimes with carbonization and exposure of muscle and bone**
Extent of burn	The size of the area of burning may be more important in the assessment of the dangers of the burn than the depth. Body surface area affected by burns may be conveniently expressed as a percentage of the total body surface area using the 'Rule of Nines'.	

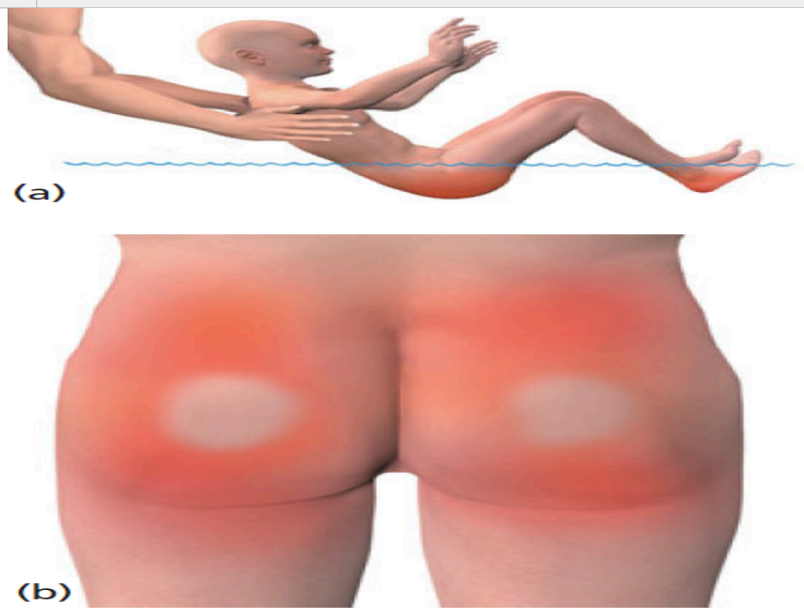
2. Scalds: The general features of scalds are similar to those of burns, with erythema and blistering, but **charring of the skin is only found when the liquid is extremely hot, such as with molten metal.**

The way of exposure	Pattern of scalding	Example
Immersion into hot liquid	Upper 'fluid level'	
Splashed or scattered droplets of liquid	Scattered punctate areas of scalding	
Runs or dribbles of hot fluid	Generally flow under the influence of gravity and this can provide a marker to the orientation or position of the victim at the time the fluid was moving	Children pulling saucepans with hot liquid off a cooker.



17.2 The 'Rule of Nines'.

Figure 17.1 The extensiveness of burns on a body recovered from a fire may be varied. This individual had second and third



5 Pattern of scalding from forced immersion

Accidental vs. intentional scalds:

	Accidental	Intentional
Injury	'Spill' injuries from 'flowing liquid'	Forced immersion in hot water
Example	From hot beverages/liquids being pulled of a table top, etc.	Child physical abuse (the most common intentional thermal injury in children), when a child is placed in a tub or bath of hot water.
Characteristics	- Scalds with irregular margins and burn depth. - Lacking a 'glove and stocking' distribution.	Symmetrical 'glove and stocking' injuries to the limbs, sparing skin folds (and buttocks in those forced to sit in hot water), which are of uniform depth

✓ Pathophysiological consequences of thermal injury:

- Burned/scalded tissue elicits an acute inflammatory response, leading to **increased capillary permeability at the injured site**; tissue fluid loss associated with thermal injury can be severe enough to cause **dehydration**, electrolyte disturbance and hypovolemic shock.

✓ Autopsy findings in 'heat illness' including 'heat stroke':

- They are non-specific but can include:

1. Pulmonary and/or cerebral oedema.
2. Visceral surface petechiae.
3. Features in keeping with 'shock' and multiple organ failure: in those who survive for a short period.

✓ Pathological investigation of bodies recovered from fires:

- **Safety of investigators** after events such as **gas explosions** is a very important consideration in the examination of fire scenes.
- The fire scene **must be examined by specialist investigators** with expertise in the interpretation of the causes and '**point of origin**' or '**seat**' of fires, and the **use of accelerants**, such as **petrol**.
- **Attendance at the scene by a pathologist is important** and assists subsequent interpretation of post-mortem findings.

✓ The pathological investigation of bodies recovered from fires should attempt to:

1-Confirm the **identity** of the deceased.
2-Determine **whether the deceased was alive at some time during the fire** (or was dead before it started).
3-Determine **why the deceased was in the fire** (and they couldn't get out of it)
4-Determine the **cause of death.**
5-Determine (or give an opinion as to) the **manner of death.**

✓ Identification of bodies:

1-Visual identification from facial features.
2-Unique medical features and factors such as the presence of scars and tattoos,
3- Dental examination and comparison of the dentition with available ante-mortem records.
4-DNA analysis.

Post-mortem radiography should usually be performed **before** dissection, with particular emphasis on radiographs to assist identification (dentition, surgical prostheses, etc.), to identify fractures (including healing fractures with callus) and to exclude projectiles such as bullets and shrapnel.

✓ Determination of 'vitality' (the fact that someone was alive) during the fire at post-mortem examination:

1) The finding of soot in the airways, oesophagus and/or stomach **(the implication that respiration was required to inhale the soot), and may be confirmed under the microscope.**
2) **Blood samples for a rapid assessment to carboxyhaemoglobin** (A level of over 50% often being considered good evidence of death having occurred as a consequence of breathing in the combustion products of fire)

✓ Deaths occurring during a fire:

- **Determination of manner of death:** While the determination of 'manner of death' usually rests with the appropriate medico-legal authority, **an opinion from the forensic pathologist is frequently sought**.
- The interpretation of injury in bodies recovered from fire is complicated by artefacts related to exposure to fire:

❖ The so-called '**pugilist attitude**' of the body reflects differential **heat-related contraction of muscle, leading to flexion of the forearms, hands and thighs.**
❖ Post-mortem splitting of fragile burnt skin
❖ Fire- and heat-related fractures
❖ **Heat-related 'extradural hemorrhage**', caused when severe heat has been applied to the scalp.

✓ **Examples of mechanisms of death in fires:**

1-Interference with respiration (owing to a reduction in environmental O2 and/or the production of CO and other toxic substances)

2-Inhalation heat injury leading to laryngospasm, bronchospasm and so-called 'vagal inhibition' and cardiac arrest

3-Exposure to extreme heat and shock Trauma

4-Exacerbation of pre-existing natural disease or burns

- ## Cold injury (hypothermia):

Cold injury (hypothermia) has both clinical and forensic aspects, as many people suffer from and **die of hypothermia even in temperate climates in winter, in marine disasters.**

Hypothermia occurs when a person's body temperature below 35°C.

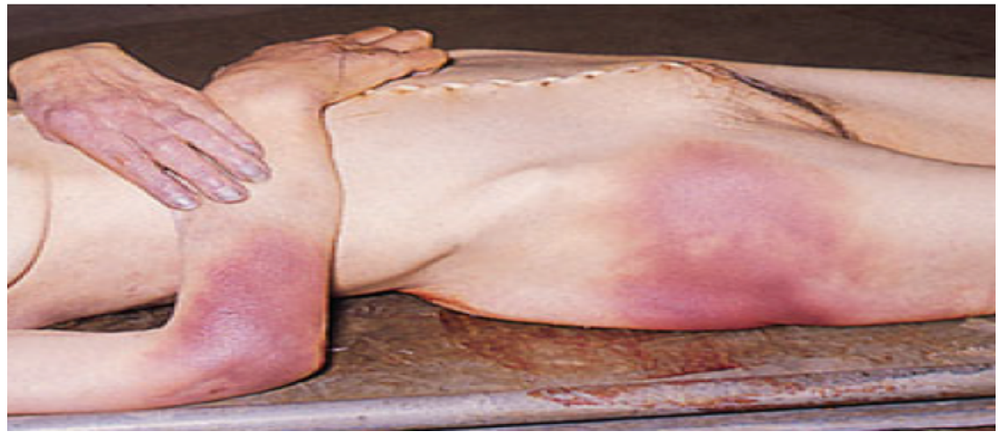
- If a body gets cold, the normal response is to warm up by becoming more active, or moving indoors.
- **If exposure to the cold continues**, other physiological processes will attempt to prevent any further heat loss.
- **These processes include shivering (tremble), restricting blood flow to the skin and releasing hormones to generate heat.**
- The body may rapidly lose temperature when sinking in cold water, as **water has a cooling effect that is 20–30 times that of dry air.**
- Generally, the elderly, children and trauma patients are more susceptible to hypothermia.

- ✓ Hypothermia can be classified into:
  Mild (32–35°C)
  Moderate (30– 32°C)
  Severe (<30°C).

Features of Mild, moderate, severe hypothermia.

Mild	Moderate	severe
shivering feeling cold lethargy cold, pale skin	uncontrollable shivering cognitive impairment confusion slurred speech	loss of control of hands, feet and limbs. unconsciousness irregular or no pulse dilated pupils

In an unrefrigerated body, **the finding of indistinct red or purple skin discoloration over large joints** raises the possibility of hypothermia and is found in approximately 50% of presumed hypothermia deaths (picture).



- The phenomenon **of 'hide and die syndrome' describes the finding of a body that appears to be hidden**, for example under furniture or in the corner of a room, etc.
- It is thought that this phenomenon reflects a terminal **primitive 'self protective' behavior** and may be more commonly observed where there is a slow decrease in core body temperature.

Death from lightning:

- Hundreds of deaths occur each year from atmospheric lightning, especially in tropical countries.
- Huge electrical forces are involved, producing millions of amperes.
- Some of the lesions caused to those who are struck directly, but other will be from burns and from the 'explosive effects' of a compression wave of heated air leading to 'burst eardrums**', pulmonary blast injury and muscle necrosis.**
- The usual textbook description is **of 'fern or branch-like' patterns**, but others claim that such marks are not seen. Although many bodies are completely unmarked.

Figure 17.21 The 'Lichtenberg figure' and lightening fatalities. Note the fern-like branching pattern of skin discoloration on the chest.

Electrical injury:

- Injury and death from the passage of an electric current through the body is common.
- **The essential factor in causing harm is the current (electron flow).**
- Almost all of the cases, fatal or otherwise, originate from the public power supply, which is delivered throughout the world at either 110 V or 240 V. (**It is rare for death to occur at less than 100 V**)
- **The current needs an entry point (hand),** and the exit is to earth **(via the other hand or the feet).**
- In either case, **the current will cross the thorax, which is the most dangerous area for a shock because of the risks of cardiac arrest or respiratory paralysis.**
- When a live metal conductor is gripped by the hand, **pain and muscle twitching will occur if the current 10 mA.**

If the current is 30 mA, the muscles will go into spasm.

If the current across the chest is 50mA or more, fatal ventricular fibrillation is likely to occur.

- The tissue resistance is important.
- **Thick dry skin, such as the palm of the hand or sole of the foot, may have a resistance of 1 million ohms, but when wet, this may fall to a few hundred ohms.**

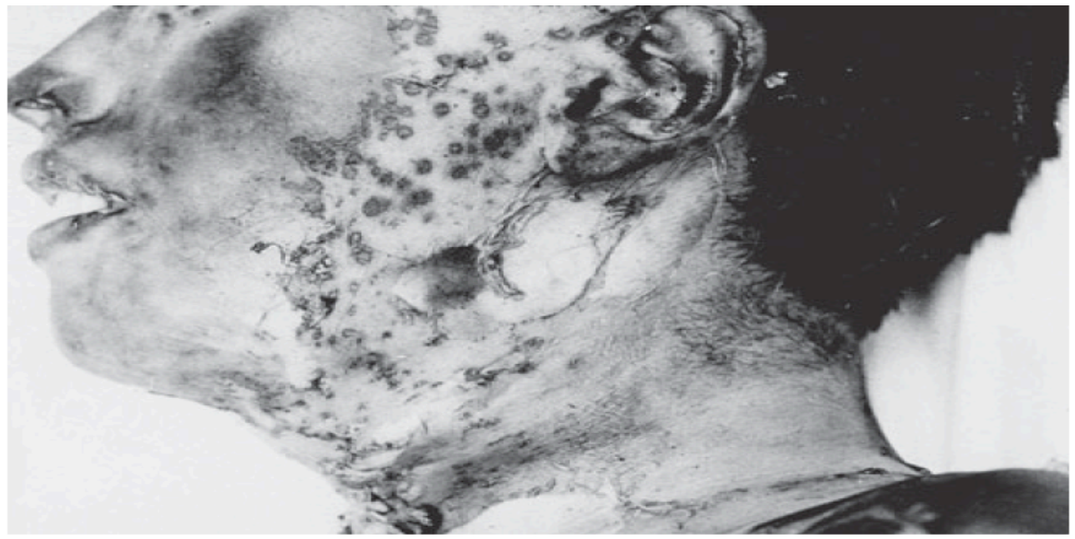
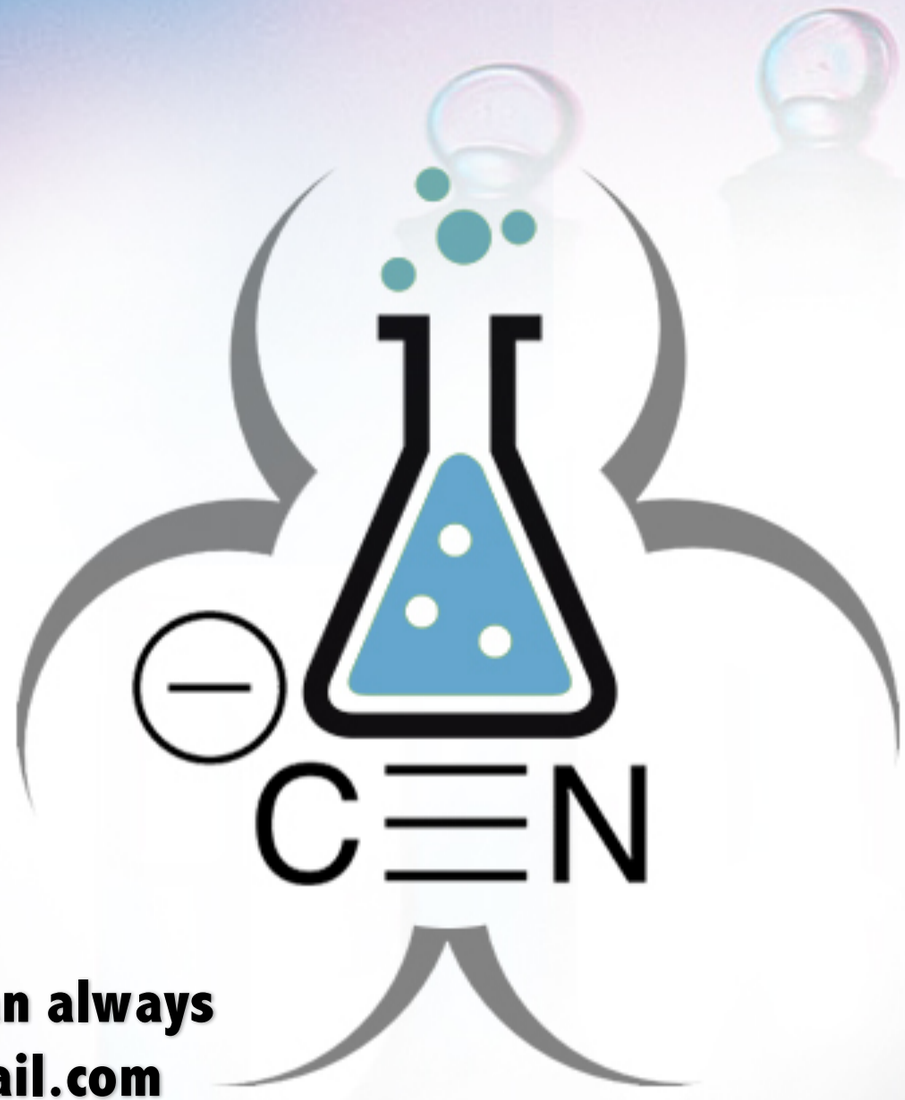


Figure 17.20 Multiple burns from high-voltage (multi-kilovolt) electrical supply lines. The 'crocodile skin' is caused by arcing of the current over a considerable distance.



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