FORENSIC & TOXICOLOGY

SUMMARY

Done by Shahed Atiyat

Death and postmortem changes

- ✓ Study of death in all its aspects is known as **thanatology**.
- ✓ **Cause** of death: injury or disease (stab wound, adenocarcinoma, …).
- ✓ **Mechanism** of death: physiologic derangement produced by the cause of death (hemorrhage, acidosis, …).
- ✓ **Manner** of death: how the cause of death came (natural, accidental, homicide, suicide or undetermined).
- ✓ **Mode** of death: the abnormal physiologic state that pertained at the time of death (coma, syncope, or asphyxia).
- ✓ **Agonal period**: the time between a lethal occurrence and death.

Postmortem changes (Immediate, early & late):

Immediate changes (Somatic death)

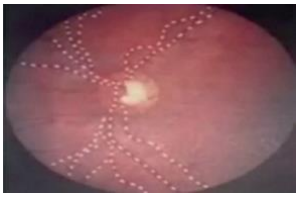
1. Irreversible cessation of the function of brain (earliest sign). Flat EEG
   - Loss of motor and sensory functions, loss of muscle tonicity, loss of reflexes, dilated pupils.
2. Irreversible cessation of respiration (>4 min). No breath sounds
3. Irreversible cessation of circulation (>3-5 min). Flat ECG

Early changes (Molecular death)

1. Facial pallor and loss of skin elasticity.
2. Primary relaxation and flaccidity of the muscles (the muscles still alive), **1 h after death.**
3. Contact flattening and pallor.
4. Changes in the eyes:
   - ❖ Loss of corneal and pupillary reflexes.
   - ❖ Pupils: constricted (was dilated in immediate changes).
   - ❖ Tache noire.
   - ❖ Kevorkian sign
   - ❖ Loss of intraocular pressure (from 10-22 mmHg to zero **within 4-8h**).
5. Algor mortis. "cooling"
6. Livor mortis. "postmortem staining/lividity/hypostasis"
7. Rigor mortis. "stiffness "

Tache noire

- Yellow triangles in sclera >> brown >> black.
- Happen due to **drying** and **deposition** of cellular debris, mucus and dust if eye opened for **3-4h** after death.



Kevorkian sign

- Retinal vessels appear segmented (cattle trucking or shunting).
- Happens within **seconds to minutes and persists for about an hour.**

Algor mortis

- **Cooling of the dead body**, where the body temperature equilibrates with its environmental temperature.
- Cause: cessation of the energy production and inactivity of the heat regulating center.
- Rate of cooling depends on: age, clothing, environment temp., mode of death, body size.
- The average rate of fall of the body temperature is 0.4-0.7°C/h [in the slide it is 1 °C/h] and the body attains environmental temperature in **16-20 h** after death.
- **Rapid cooling delays the rigor mortis and decomposition.**

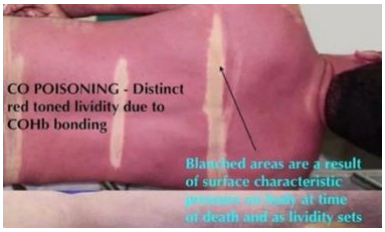
The measurement of the inner core temperature (**rectally**) is more reliable than the outer surface temperature

Livor mortis

- Normal color is **bluish or purplish-red** discoloration.
- Cause: Gravitational settling of the blood in the toneless vessels.
- Site: Undersurface of skin in the superficial layer of the dermis.
- The non-stained areas are called **contact pallor (due to the pressure).**
- **Strat after 30 min to 1 h as small patches >> increase in size after 3-4h >> fully developed in 5-6h. If the body is undisturbed, it will be fixed in 8-12h and persist until putrefaction.**

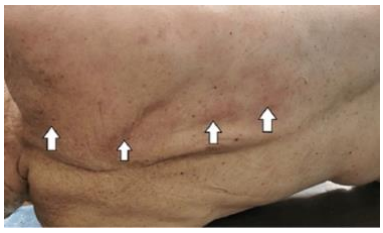
Bright red Livor mortis

Seen in **cyanide** poisoning



Cherry red Livor mortis

Seen in **CO** poisoning



Pale/ not well-developed Livor mortis

May be due to **anemia** or **hemorrhage**

Difference between Livor mortis and bruises:

Livor mortis	**Bruises**
Dependent area	Any where
Well defined edges	Ill defined edges
Intact capillaries	Ruptured capillaries
Blanchable	Unblanchable
Superficial	Deep into the skin
Incision: blood flows from cut vessels (washable)	Incision: blood coagulate in the tissue
No swelling	May be with swelling
Same level on surface	Raised

Rigor mortis

- **Muscle stiffening & rigidity** with some degree of shortening.
- Caused by persistent attachments of actin filaments to myosin due to the lack of ATP along with the loss of muscle softness and elasticity.
- **Starts 1-2 h after death (after primary relaxation), takes 9-12h to develop from head to foot, persists for 12h and takes 12h to pass off.**
- **Develops faster in case of electrocution (faster ATP depletion) & high temperature.**
- Occur in voluntary and involuntary muscles (earlier in the involuntary like the **heart**).
- Seen first in the small muscles, primarily the eyelid (orbicularis oculi), jaw & neck.
- Among voluntary muscles develops **sequentially** & **descending** pattern.
- The rigidity disappears in the same order in which it has appeared.
- Stays for maximum duration in the muscles of the lower limbs.

Cadaveric spasm

The muscles were contracted immediately **before** death and continue to be so after death **without passing through primary relaxation.**

It's **antemortem** phenomenon reflects the last act of the body.

Heat stiffening

The body is subjected to a heat exposure > 65 °C. There will be **coagulation of the muscle protein**, flexors affected more >> ***pugilistic attitude*** of the body.

Cold stiffening

The body is exposed to freezing temperature for a reasonable period, the tissue become frozen and stiffed stimulating rigor. There will be a **freezing of body fluids and harding of the subcutaneous fatty tissue**.

Note: **Secondary relaxation** occurs after rigor mortis. It occurs with the onset of decomposition or putrefaction.

Late changes

1. Decomposition / putrefaction

- Breaking down of complex organic tissue into simpler inorganic compounds due to autolysis or action of saprophytic microorganisms.
- Clostridium Welchii is the main organism in putrefaction.
- External signs: 4 Ds (Discoloration, Distention [gas accumulation], Degradation, Dissolution).
- Internal signs: Organ decomposition, uterus and prostate being the last organs to decompose.
- **Degradation**: loss of integrity of skin (skin slippage, degloving & loosening of hair and nails).
- **Dissolution**: occurs with progressive decomposition that leads to liquefaction and disappearance of tissue and organs and eventual skeletonization.
- **Putrefaction occurs earlier in hot, air, humidity, infection or septicemia before death.**

Table 9.6: Order of putrefaction	
Early putrefaction	**Late putrefaction**
i. Larynx and trachea	i. Heart, lungs, kidneys
ii. Stomach, intestines	ii. Esophagus, diaphragm
iii. Spleen	iii. Blood vessels
iv. Liver	iv. Bladder
v. Brain	v. Prostate, uterus (non-gravid)
vi. Gravid uterus	vi. Skin, muscle, tendon

Decomposition of Submerged Body

Casper's dictum states that rate of decomposition in air is twice as rapidly as in water, and eight times as rapidly in deeply buried bodies, i.e. 1 week of putrefaction in air = 2 weeks in water = 8 weeks in soil at similar temperature, but this dictum is not useful practically.[32-34] The deeper a body is buried, the better its preservation during an elapsed period of time.

The process of decomposition in water is slow due to:

- Exclusion of air
- Protection by clothes
- Early cooling of the body

Discoloration

The first external sign of decomposition, **starts 2 days after death.**

Greenish discoloration in the right iliac fossa; due to the reaction between H2S and deoxygenated Hb. Internally, this is seen under the surface of the liver.

Clostridium Welchii is most abundant in the iliocecal zone.

Marbling of skin

First appear in the shoulders, roots of limbs, thigh, sides of abdomen, chest and neck. It marks the passage of bacteria in the vessels; happens due to decomposition of Hb to **sulphmethemoglobin** in the inner wall of superficial vessels.

Onset: In summers, it is seen in 36-48 h after death.

2. Adipocere (Saponification)

- The **surest** sign of death.
- Occur in the fatty tissue and it is a modification of the decomposition.
- **In hot and moist environment, it may occur by the end of 1 week. In temperate countries, it starts in 3 weeks and completes in about 3 months.**
- **Favorable factors: hot, humid anaerobic environment &, moist & water.**

3. Mummification

- **Onset: 3-12 months after death.**
- It is a modification of decomposition (dry decomposition).
- Rapid dehydration of the dead body with preservation of the natural features of the body. The body loses weight and becomes thin, stiff and odorless.
- **Favoring factors: hot, dry & free air environment, poisoning (chronic arsenic and antimony poisoning).**

Notes

- ✓ Skin and bone remains metabolically active for many hours and can be successfully cultured days after somatic death.
- ✓ Nervous tissues die rapidly, the vital centers of the brain die in 3-7minute, muscles survive up to 1-2 hours.
- ✓ **Suspended animation**: vital signs of life (HR & RR) are not detected by routine clinical methods; the metabolic rate is greatly reduced & the requirement of the cells for oxygen is satisfied by dissolved oxygen in body fluids. May be **voluntary** (yoga) or **involuntary** (hypothermia, drowning, electrocution, poisoning by opiates & barbiturate, newborn, post-anesthesia, cholera, shock, heatstroke, burn).
- ✓ In the primary relaxation the muscle is still alive and respond to electrical stimulus but when the rigor mortis happens this indicated a molecule death of that muscle.
- ✓ Rigor mortis in the uterus of the pregnant will not cause expulsion of the fetus.
- ✓ Postmortem pupil constriction is unreliable indicator of toxic or neurological condition.
- ✓ If the rigor mortis involve the whole body this indicates that the time of death between 12-24h back.
- ✓ Maceration it is a aseptic autolysis of the dead fetus in the uterus.
- ✓ In the decomposition, organs that composed of more muscular and fibrous tissue resist putrefaction longer than parenchymatous organ except the stomach and intestines which decompose rapidly.
- ✓ Livor mortis mostly help in determining the position of the dead body.

	Somatic death	Molecular death
Onset	Proceeds molecular death	Succeeds somatic death (1-2 hours after stoppage of vital functions)
Tissue and cells of the body	Alive and functioning	Dead and non-functioning with no metabolic activity
Response to external stimulus	Muscles respond to thermal, electrical or chemical stimulus	Does not respond
Confirmation	Flat ECG and EEG and absent breath sound	Rigor mortis, algor mortis, postmortem staining & putrefaction
Resemblance	Suspended animation, coma, hypothermia	Dose not resemble any condition