TANATOLOGY

Definition of death - Dying of cells in different time

The (pre)-agony is characterized by the diverse duration (during hours, days) of deep violations and turnig down of the vitally important organism functions. A stage which precede to the death.

Ireversible state

Recognising of the state (v.s. VITA MINIMA – reversible state)!

Characteristcs:
- hypoxia, hypotermia, respiratory disfunction, decreasing of the arterial pressure, wikness of sensors, the darkening down of the consciousness
- characteristic appearance: Hippocratic face - the nose is pinched, the eyes are sunk, the temples hollow, the ears cold and retracted, the skin of the forehead tense and dry, the complexion livid, the lips pendent, relaxed, and cold
- changes on internal organs

Types:
- **clinical death** the absence of heart beat (no pulse can be felt) and cessation of breathing. Most tissues and organs of the body can survive clinical death for considerable periods. Blood circulation can be stopped in the entire body below the heart for at least 30 minutes. Detached limbs may be successfully reattached after 6 hours of no blood circulation at warm temperatures. Bone, tendon, and skin can survive as long as 8 to 12 hours.
- **brain death** - the irreversible cessation of all brain activity for an appropriate observation period, at least 24 hours, so that cardiopulmonary functions must be artificially maintained
- **cerebral cortical death** (apalijski sindrom) - where the cerebral cortex suffers irreparable damage and put the individual in a vegetative state; spontaneous function of cardiorespiratory system
- **biological death** - the cessation of all vital functions of the body including the heartbeat, brain activity (including the brain stem), and breathing. Characterized by the irreversible changes in the organism.

Between life and death:

agony → clinical death→ cerebral death
→ (supravital time/ premortal phase) → biological death

Brain cells – sperms and respiratoy epithelium

Supravital time - period of biological dying of certain cells, tissues and organizm as a whole (intermedium life). Because of: possessing a varying degree of oxygen shortage tolerance so the damages also appear in different rates. The most sensitive cells that are incapable of regeneration are the neurons, consequently the cerebral tissue is the one that can sustain its life without oxygen and nutrients (glucose) for the shortest time (4–5 minutes) at regular temperature. Problems with moment of explantation.

1982.: Bylaw on medical criteria and way of establishing cerebral death in persons from whom is possible to take body parts due to transplantation

Person in deep (irreversible) coma because of cerebral injury, dekomp. Intracranila tumor or cerebrovascular disease

An absence of cerebral and brain stem function(pupils are unchanging, no gag reflex, limbs are flaccid), apnea; must rule out hypothermia, drug intoxication and the person is not in shock;. 12 hours without an EEG response or other EEG measure, no cerebral blood flow

AUTOLYSIS AND HETEROLYSIS

Early and late signs of death

Autolysis (anaerobic, aseptic chemical process) - self-digestion, refers to the destruction of a cell through the action of its own enzymes at the moment of death pH movement towards acid → strong activation of enzymes → destruction of own tissues

Associated processess: decomposition and disintegration

Clear autolysis: maceration of fetus

Changes on internal organs: parenchimal, stomach, gall-bladder, respiratory tract, pancreas

EARLY SIGNS

Paleness (palor mortis)
Lividity (livores mortis)
Death stiffening (rigor mortis)
Drying (dessicatio)
Cooling (algor mortis)

1. Postmortem lividity – *livores mortis*
   - *purpura or* petechial-like hemorrhages due to capillary rupture in areas of deep hypostatis *vibices*, at the opposite site paleness of the body - *pallor mortis*
   - accumulation of blood in the small vessels secondary to gravity – postmortem hypostasis
   - opinion: hemoconcentration (proof: movement, possibility of washing out)
   - usually after 45 min. on lateral parts of the neck
   - division
   - color
   - Medico-legal importance:
     - It is a sign of death.
     - Its extent helps in estimating the time of death.
     - It indicates the posture of the body at the time of death.
     - It may indicate the moving of the body to another position sometime after death.
     - Sometimes the color may indicate the cause of death.
2. Cadaveric rigidity – *rigor mortis*
   - It develops gradually in all the muscular tissues of the body.
   - Beginning: within 30 min. in the heart muscle "deceased's cry"); starts within 2–4 h in the skeletal muscles; develops fully in 5–8 h; resolves within 24–48 h
   - With irreversible circulatory arrest, all body muscle become completely flaccid
   - Reason: ATP theory (after death generation of ATP stops; ATP level below 85% of the initial value, actin and myosin filaments will contract)
   - Resolution: due to protein degradation (until decomposition occurs)
   - 4 phases:
     1. Delayed - flacciditas mortis primaria (up to 2-4 h)
     2. Reversible (6-8 h)
     3. Irreversible (24-48 h)
     4. Resolution - - flacciditas mortis secundaria
   - Specific type – cadaveric spasm (max. pronounced at the time of death: violent exercise, severe convulsion, body temperature)
3. Drying – *desscicatio*
   - occurs because of - stop of circulation, hypostasis and external factors
   - rapid on parts covered with thin epithelium and at places of abrasions

- changes - color of the skin, histology changes, sclera drying, decrease of the weight of organs

4. Cooling – *algor mortis*
   - The rate of cooling depends on:
   - ambient conditions (temperature, wind, rain...)
   - weight of the body, mass/surface
   - posture of the body
   - clothing/covering
   - due to: convention, conduction, radiation and evaporation
   - sequence of developing
   - "condensation of the corpse" (from lower to higher temp.)
   - Measurement!
   - first 4 h for 1 degree, after 24 h like environment
   - determination of the time of death:
   - Time since death = 37º - rectal + 3
   - Henssge nomogram: body weight, environmental temperature, rectal temperature with corrective factors (clothing/covering, in air/water)

LATE SIGNS OF DEATH

Destructive changes: decomposition (putrefactio), rottening (maceratio) and disintegration- advanced putrefaction (putrefactio gr. gravis), destroy the external appearance

Preservation changes: mummification and adipocere, partially keep the external appearance

Destructive changes

1. Decomposition (autolysis and putrefaction)
   - Influenced by internal and external factors (bacteria and fermentation) and final breakdown of proteins, carbohydrates and fats
   - pseudomelanosis, marbling, bacterial gas formation: bloating of the body, blisters, purge fluid, peeling of hair and skin, diffusion of fats
   - Smell of decomposition due to metabolic products of oxygenation (ammonia; attracts blow flies and flesh flies; kadaverin, putrescin – other faunas)
   - Destructive changes
2. Rottening
   - cloth disintegration
   - sweetish smell like rotten apples
3. Advanced putrefaction
   - after cca 3 w. – soft tissue disappear, corpse is dried
   - butter smell due to effect of butyric acid, (no flies larvae, activities of beetles)
   - Destructive changes
4. Skeletonization
   - in the ground as earliest after 3-4 y.
   - Changes of organisms (anaerobic → aerobic)
   - Effects of insects and other faunas
   - Depends on: temperature, humidity, presence of air, obesity, heavy clothing, sepsis
   - *Casper* rule

SPECIAL TYPES

MUMIFICATION
- in hot, dry climates, rapid dehydratation
- end 0,5 – 1 y. (primary/secondary)
- skin: brown to black leathery appearance

ADIPOCERE
- in water or in damps, warm environments
- produced by conversion of neutral fats to oleic, palmitic and stearic acids (hydrolysis of fats to free fatty acids)
- beginning: 1-2 m., end: after 100 y.
- skin: firm, grayish-white to brown

3. Animal bites
- Domestic and wild animals, insects (! flies)

Estimation of the time of death
1. Changes on the corpse:
- early:
  - mechanical and electrical excitability of skeletal muscle (4-8 h, 1-8 h)
  - corneal drying and reaction of pupils (up to 1 h, up to 4 h)
  - vibration of respiratory epithelium (up to 48 h)
  - alive spermatozoids (up to 83 h)
  - state of digestion (1-8 h)
  - blood changes: glucose, urea, kreatinin…
  - enzymes, electrolytes, hormones….
  - cooling, livor mortis, rigor
- late:
  - putrefaction (on air 1 w., in the water 2 w., in the ground (type of soil) for 8 w.)
  - pseudomelanosis, mummification, adipocere
  - skeletonization

2. Signs around (snow, humidity, etiolization)
3. Indirect signs (criminalistics)

EFFECT OF ANIMALS ON HUMAN BODY
Post-mortem changes/injuries that could lead to wrong interpretations
Possibility of complete destroy of body / parts
Changes of signs on cause and manner of death
5 groups of animals (in closed/opened spaces; on the air/in the water)

1. Insects
- flies - lesions by sucking or stabbing (suggest on stab wounds with ice pick or on gunshot wounds of small caliber)
- ants - small damages as abrasions
- the rest of arthropods

2. Birds
- in later phase of decomposition
- triangular or pin point lesions (sea-gulls: as shotgun wounds)

3. Rodents

- in first days after the death
- lesions as ante-mortem ulcerations
- mostly on: face, scalp, fingers (skeletal remains: due to minerals)
- Typical double parallel traces from upper incisors

4. Sea animals
   - small fish – abrasions
   - crabs – similar to incised wounds
   - sea lies (crustaceans, voracious feeders) – entering the body through wounds or any available orifice
5. Mammals - carnivores
   - small ones and domestic animals – in early post-mortem phase (baiting, tearing)
   - big carnivores – severe damages and moving body parts

5 phases: 0 = 4 h – 14 d. (soft tissue)
4 = 5 – 52 m. (complete disarticulation)

BODY FARM
Is a research facility where decomposition can be studied in a variety of settings
The aim: to gain a better understanding of the decomposition process of human remains
The original "Body Farm“: University of Tennessee; was first started in late 1981 by anthropologist Dr. WM Bass (forensic workshops organized by FBI)
To understand the timing of death and the circumstances under which it might have occurreda

CRIMINALISTS ODOROLOGY
The science of smells
A method of identifying human scents
Has been used in France since 2003 to establish that individual has been present at a crime scene
Is based on the fact that each person has their own scent (types of micro traces that cannot be eliminated; cca 300) and relies on the powerful canine sense /Cadaver dog/ of smell (which can be 200 to 10,000 times more sensitive than that of a human beings

The five decompositional stages

Decompositional stage	Description
(1) *Fresh*	From death until the first signs of bloating Autolysis
(2) *Bloated*	Putrefaction mechanism - accumulation of gases causing bloating of the corpse Anaerobic fermentations
(3) *Active decay*	Darkening of the skin The skin is breaking up and the body began to deflate Protein sources are broken down into fatty acids and other decomposition products such as skatole,indole, cadaverine, putrescine
(4) *Advanced decay*	Corpse dries and the remains are skin, cartilage, hair, bones and some fragments of flesh
(5) *Dry remains or Skeletonisation*	*T*he only remains are bones and hair

MISTAKES WITH ASSESMENT OF POSTMORTAL CHANGES

- Autolitycal changes (e.g., gastromalatia)
- Bleeding above vertebra
- Changes with connection of high temperature
- Acute asphyxia with severe bleeding
- Blisters on the skin
- Consequences of cadaveric emphysema
- Livor mortis
- Consequences of reanimation
- Possibility of mixing with animal changes or consequences of trauma

CORONER SYSTEM

Duty: to establish the fact of death, cause of it and time of occurring

*R*egulated by: by-law "Way of examining dead persons and establishing time and cause of death
Health care law – "Establishing cause of death and autopsy"

- Obligatory examination of deceased
- Who and when
- Time of examination and funeral
- In case of vita minima: start with PCR
- In case of infective disease: conduct measures for spreading, inform authorities
- In case of violent deaths: inform LEA
- Fulfill officials forms
- Permit burial

Public health aspects:

- Influence on mortality statistics

  data about deceased → State department for statistics → Croatian department of public health (control of forms) → State department for statistics → European regional office of WHO
- measuring the quality of health state and standards, quality of living,
- estimation of problems and necessities
- planning future activities and priorities