

Thanatology

Word root

Thanatology (Greek)

→ Thanatos + logos
= death + science

→ It is a branch of medical science that deals with the study of death.

→ It also includes,

- a) Cause and phenomena of death
- b) bodily changes that accompany death i.e., post-mortem changes
- c) their medico-legal significance.

DEATH:-

It is permanent and irreversible cessation of functions of the three vital systems of the body namely, the nervous, circulatory and respiratory system.

An individual who has sustained either,
1) Irreversible cessation of circulatory and respiratory functions.

2) Irreversible cessation of all functions of the entire brain, including the brain stem, is dead.

Section 46 of IPC - states that death denotes the death of human being unless the contrary appears from the context.

Section 2 (b) of the Registration of Birth and Death Act 1969 defines death as "permanent disappearance of all evidences of life at any time after live birth has taken place."

Medicolegal Implications of Death

1. Declaration of death -

wrong declaration of death and shifting the body for cremation / burial or at mortuary may land the doctor in trouble.

2. Certification of death -

A doctor have to certify death of a person and death certificate cannot be issued unless death of the person is confirmed.

3. Disposal of the body -

Mistake in diagnosis and certification of death may cause difficulty for proper disposal of dead as per religious affiliation.

4. Organ transplantation :- cadaveric organs or tissues for transplantation cannot be retrieved from a person unless the person is certified to be dead.

5. Presumption of death - vide infra.

STAGES OF DEATH:

Death occurs in two stages.

1. Somatic, systemic or clinical

2. Molecular or cellular.

Somatic death:-

* Also called as clinical or systemic death.

* Somatic death is characterized by complete loss of sensibility and the ability to move.

* Somatic death corresponds to with physical stoppage of functions of heart lung & brain.

* However individual cells may not die and respond to chemical, thermal or electrical stimuli.

For example - pupils muscle may contract on application of myotic drug.

Molecular death:-

* Also called as cellular death.

* Molecular death means the death of individual cells of different tissues or organs

* In absence of circulation and respiration different cells die their molecular death at different times after somatic death depending on the metabolic activity and availability of oxygen.

* Thus after somatic death, cells die in piecemeal process.

Heart - 15 min

Kidney - 30 min

Liver - 40 min

Muscles - 3 hrs

Blood - 6 hrs

Cornea - 6-8 hrs.

* The gap b/w somatic death and molecular death is important for two reasons.

1. Disposal of the body - In rare instances, the spontaneous movements of muscle may occur after somatic death and if such movements are witnessed or perceived by lay persons, the event may give rise to apprehension that the person was not actually dead but was prematurely disposed off

2. Transplantation purpose - In this period b/w somatic and molecular death, organs from the dead body can be retrieved for the purpose of transplantation in other person

BRAIN DEATH

For applied purpose brain death is classified as

1. Cortical brain death
2. Brainstem death
3. Whole brain death

① Cortical Brain Death.

* Also called as cerebral brain death or persistent vegetative state.

* In this condition, clinically patient is in irreversible coma & shows sign of severe brain dysfunction with loss of higher levels of cerebral activity.

* Such vegetative people are not considered as dead but because of irreversible loss of awareness; they are considered as "living cadavers".

② Brain stem death

* Practically brainstem death is considered as death of a person, because the vital centres that control respiration, cardiac activity and ascending reticular pathways that awakens are lost irreversibly and permanently.

* Here the cerebrum may be intact but functionally cut off from the brainstem

3. Whole brain death:-

- * Also called as mixed brain death.
- * It consists of combination of both cortical and brainstem death.
- * Brain death occurs in steps and the cells die because of anoxia.
- * The first part of the brain to die is the cerebral cortex followed by midbrain and brainstem.

Importance of determination of brain death:-

1. The earliest determination of brain death for prompt harvesting of organs for transplantation.
2. The legality of discontinuation of life supporting equipment.
3. The determination of the time of death in criminal and civil litigation.

Determination of Brainstem Death.

Brain death determination is done, in India in accordance with provisions laid down in the transplantation of Human Organs Act 1994 and is certified by board of medical experts consisting of

- a) The Registered Medical Practitioner (RMP) in-charge of the hospital in which brainstem death has occurred.

b) An Independent RMP, being a specialist, to be nominated by the RMP in-charge of the hospital from panel of names approved by the appropriate authority.

c) A neurologist or a neurosurgeon to be nominated by the RMP in-charge of the hospital from

the panel of names approved by the appropriate authority.

by the RMP treating the person whose brain-stem death has occurred.

Diagnosis of brainstem death depends on the following conditions:

1. The patient must be in deep coma and the cause of coma is irreversible structural brainstem damage" must be established.
2. Exclusion of the other causes of coma (Hypothermia, central nervous system depressant drugs such as barbiturates, benzodiazepines etc. overdose / poisoning, metabolic or endocrine disturbance, intoxication (alcohol)).
3. Demonstrating the absence of brainstem reflexes
4. No spontaneous respiration.
5. The brain dead person must be examined by board of medical experts twice at an interval of 6 hours.
6. The brain-death certificate has to be signed by all the member of board.

→ Structural and functional damage of brainstem death should be assessed from the absence of following brainstem reflexes.

1. Absence of pupillary response
2. Absence of corneal reflex
3. Absence of vestibulo-ocular reflex (caloric response)
4. Absence of grimace
5. Absence of cough / gag reflex.
6. Absence of cranial motor nerve response to painful stimuli

7. Absence of Spontaneous respiration.

APPARENT DEATH

* Also called as suspended animation

* It is defined as;

a state of body in which the vital functions are at such a low pitch that the body functions cannot be determined by ordinary methods of clinical examination"

* In suspended animation, a person may last for few seconds to half an hour or more

* In this condition, actually, the circulation, respiration etc. do not completely stop but is being maintained in their minimum.

* Cause - Yogr, Transe; Hysteria, Sunstroke, Concussion, Drowning, Electrocuton, Frozen coma, Narcotics, poisoning, Anaesthesia.

MODES OF DEATH / PROXIMAL CAUSE OF DEATH.

The mode of death refers to "an abnormal physiological state that pertained at the time of death".

There are three modes of death depending upon the system most obviously affected, irrespective of what the remote cause of death may be;

1. Coma
2. Syncope
3. Asphyxia.

1. Coma:-

It is a state of profound unconsciousness from which a person cannot be roused, with minimal or no detectable or responsiveness

to stimuli

This is death from failure of the function of the brain.

CAUSES:-

It is mode of dying seen in:-

- * Injury or disease of the brain
- * Systemic disorders, such as diabetic ketoacidosis, uraemia, heat stroke or eclampsia
- * Intoxication with alcohol, opium, cocaine, chloral hydrate, anaesthetics, atropine, cyanide or phenol.
- * Other condition: Severe catatonic states.

SYNCOPE:-

This is death from failure of the function of the heart resulting in hypoxia and hypoperfusion of the brain

causes:-

- * Heart disease
- * Pathological state of blood Hemorrhage
- * Exhausting disease
- * Vagal inhibition
- * Poisoning: Digitalis, tobacco, aconite and oleander.

ASPHYXIA:-

This is death from failure of the function of the lungs.

- * It occurs in pathological conditions of the respiratory system, such as pneumonia, paralysis of the respiratory center (as in opium poisoning), occlusion of air passages.

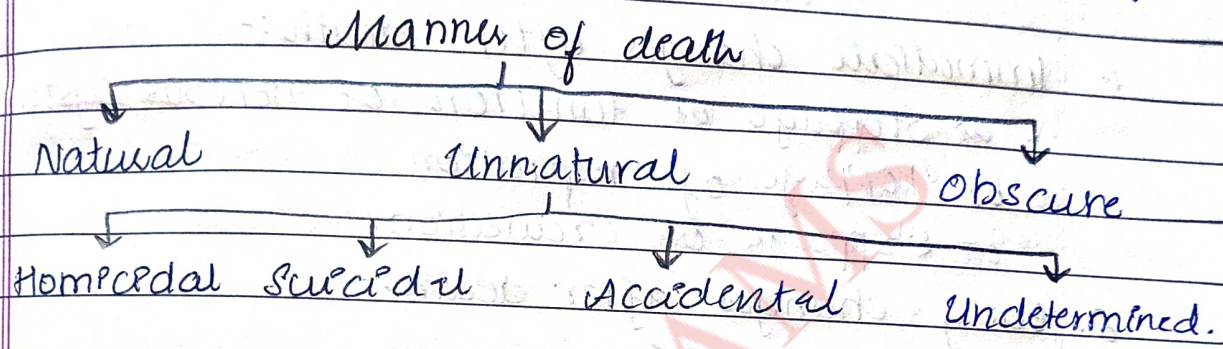
breathing of irrespirable gases and traumatic asphyxia.

* In all these conditions, respiratory function ceases before that of the heart.

MANNER OF DEATH.

Manner of death refers to the way (or design / fashion) in which the cause of death comes into being.

Accordingly manner of death is classified as:



Descriptions of manners of death.

Manner	Defination:-
1. Natural	Death resulting from disease / old age
2. Homicide	Death resulting from the deliberate action of another
3. Suicide	Death intentionally self-inflicted
4. Accident	Death as a result of an environmental influence

CAUSE OF DEATH

Cause of death is any injury or disease producing physiological derangement; briefly or over a prolonged period and which results in the death of an individual.

eg:- A gunshot wound to the abdomen, stab wound to the chest, adenocarcinoma of the lung or coronary atherosclerosis

CHANGES AFTER DEATH.

The changes which occur after death that are helpful in estimation of the approximate time of death (and to differentiate death from suspended animation).

This can be classified into:

1. Immediate changes after death:-

- a) Stoppage of function of nervous system
- b) Stoppage of respiration
- c) Stoppage of circulation.

2. Early changes after death:-

- a) changes in skin
- b) Primary relaxation of muscles
- c) changes in eye
- d) cooling of body
- e) postmortem lividity
- f) Rigor mortis
- g) changes in muscle

3. Late changes after death

- a) Putrefaction or decomposition
- b) Adipocere
- c) mummification.

Immediate changes after death [somatic changes]

a) Irreversible cessation of the function of brain including brainstem;

* This is the earliest sign of death with

stoppage of functions of the nervous system

* There is insensibility, and loss of both sensory and motor functions.

* There is loss of reflexes, no response and no tonicity of the muscles.

* Pupils are widely dilated.

b) Irreversible cessation of respiration:

Complete stoppage of respiration for >4 min usually causes death.

The stoppage of respiration can be established by the following tests.

1. Inspection:- No visible respiratory movement.
2. Palpation:- No respiratory movement can be felt.
3. Auscultation:- Breath sounds cannot be heard from any part of the lungs.
4. Feather test, mirror test and Winslow's test are no longer utilized.

c) Irreversible cessation of circulation:

Complete stoppage of respiration for >3

Stoppage of heart beat for $>3-5$ min is irrecoverable and results in death.

The following tests may be performed to test circulation:-

- i) Radial, brachial, femoral and carotid pulsations will be absent; if the circulation has stopped.
- ii) Auscultation of heart. Absence of the heart beat over the whole precordial area and particularly over the area of the apex.
- iii) ECG - In case of cessation of circulation, the ECG curve is absent and the tracing shows a flat line without any elevation or depression.

47 Other tests - Various tests, like d'Arphanous (transillumination test), Magnus (ligature test), E-card; pressure tests are now obsolete.

Early changes [Molecular death]

a) Changes in the skin & facial pallor

* Skin becomes pale and ash-white due to stoppage of circulation and drainage of blood from the capillaries and the small vessels

* The skin loses its elasticity, and the face looks younger due to loss of creases.

* The lips appear brownish; dry and hard due to drying

* Cutis anserina may be observed.

b) Primary relaxation or flaccidity of the muscles

* Muscles lose their tonicity and become flaccid but the muscular tissues are still alive, their chemical reaction is alkaline and responds to electrical stimuli

c) Contact flattening and pallor

The areas which remain in contact with the ground; become flat and the blood from vessels of these areas is pressed out, this continues even after the formation of postmortem staining over the surrounding areas.

d) Changes in the eye:-

? Loss of corneal and pupillary reflexes:-

After death the pupils are fixed and widely dilated and do not react to light

* It may be seen in all cases of deep insensibility and therefore is not a reliable sign of death.

ii) Corneal changes:-

There is opacity and haziness of the cornea due to drying and deposition of dust and debris over it. This may be delayed, if the lids are closed after death.

* The haziness is transient and passes off, if a drop of water is poured on the cornea.

* But the cornea becomes permanently hazy after about 10-12h of death due to the decomposition.

iii) Pupils:-

The pupils are dilated after death, because of the relaxation of muscles of the iris.

Due to loss of tone and elasticity of the ciliary muscles after death, the shape of the pupil can be changed.

iv) Tache noire sclerotiques (French - black line):-

* Change is seen in sclera when eye remains open.

* It is developed because of drying and desiccation of the conjunctiva and sclera.

* Appears as blackish brown discoloration.

* Within 2-3 hours, the exposed white part of eyeball becomes yellowish.

* Within 8-10 hrs it becomes blackish brown.

v) Loss of ocular tension:-

Ocular tension falls rapidly after death and within about 2hrs it becomes zero.

* Thus eye looks sunken after death.

vi) Retina and choroid plexus:-

* The blood in the retinal vessels appears fragmented or segmental (cattle trucking or shunting) within seconds to minutes after death, and persists for about an hour (Kerovokan sign).

* Can be seen only in retina by an ophthalmoscope.

ALGOR MORTIS

→ cooling of the dead body.

* Algor mortis (Latin: - algor = coolness, mortis = death) or chill of death.

* It is the cooling of the body that normally takes place after death, where the body temperature equilibrates with its environmental temperature.

* The surface (outer) temperature falls more rapidly for some time than the inner core temperature.

Cause:- Due to cessation of energy production and inactivity of the heat regulating center after somatic death.

* Loss of the body heat occurs by conduction, radiation and evaporation.

The curve of cooling pattern is sigmoid, biphasic or inverted 'S' shaped.

* Initial plateau (isothermic phase) - no fall in core temperature for the first 1-2h. This is due to the thickness of the skin and the subcutaneous tissue.

* Some hours after death, the fall of temperature at the inner core of the body achieves a regular, linear and constant pattern (intermediate phase).

* The last part of the curve (terminal phase) is slightly above the base line which is indicative of bacterial activity.

* For the purpose of estimation of time passed after death, the measurement of the inner core temp^r is important and is more reliable than the outer surface temperature.

Sites to record inner core temperature:-

→ Rectum (8-10 cm above anus)

→ External auditory meatus

→ Subhepatic (inferior surface of liver).

* Chemical (not clinical) thermometer 10-12 inches long with graduation ranging from 0-50°C is required.

* Now-a-days digital probe thermometer is used which can measure -40°C to 110°C.

* Hourly recording of the body temperature is more valuable for the purpose of determination of time since death.

* The use of this method is practical in cool & temperature climates.

* But in tropical countries (like in India) there may be a minimal fall in body temperature postmortem.

* The average rate of fall of the body temperature is 0.4 - 0.7°C/h and the body attains environment temperature in 16-20h after death.

* A rough estimate of time since death (TSD) is obtained by the formula.

TSD (in hrs) = $\frac{\text{Normal rectal temp}^r - \text{measured rectal Temp}^r}{\text{Rate of fall of temp}^r \text{ per hour}}$

Rate of fall of temp^r per hour.

Factors affecting algor mortis:-

1. Environmental Temperature - major factor.
Rate of fall of body temperature is directly proportional to the difference b/w the temp of the dead body and the environmental temp.
2. Air movement - over the surface of the dead body causes a quick fall of temperature due to increased evaporation of body fluids.
3. Humidity :- cooling is more rapid in a humid rather than in a dry atmosphere.
4. Media of disposal :- cooling is earliest in water and late in buried bodies.
The ratio of the rates of fall of temperature in three media,
water : air : soil (buried bodies)
4 : 2 : 1
5. Built of cadaver: obese bodies cool slowly, and lean bodies rapidly.
6. Age and sex: Rate of loss of heat is more in children and the elderly compared to adults. Females retain body heat for a comparatively longer period because of their subcutaneous fatty tissue.
7. Clothing or covering of the body: A well-covered body retains heat for a longer period as compared to a naked or thinly clothed body.
8. Position and posture of the body:- If the body lies in supine and extended position, the loss of heat is rapid.
9. Mode of death - In case of sudden death in a healthy individual, the body tends to cool slowly, whereas in death due to long and wasting illness, the body cools rapidly.

Postmortem Caloricity:

* In this condition, instead of cooling, the temp^r of the dead body remains high for the initial 2 hours → This is due to,

a. Postmortem glycogenolysis - Compulsory phenomenon which occurs in all dead bodies, and which starts soon after death (produces upto 140 calories i.e. rise in 2°C / 3.6°F).

b. Cause of death:

* Death due to infectious diseases, septicemia or bacteremia - heat is produced by the action of the infective organisms.

* Death is preceded by the severe convulsion (tetanus and strychnine poisoning), it causes an increase in the body temperature.

* Death due to heat stroke or pontine hemorrhage, the heat regulation is severely disturbed before death.

c. High environmental :- when the environmental temperature is higher than the body temperature, the dead body may absorb some heat.

MEDICOLEGAL IMPORTANCE:

1. It is a sign of death.
2. It helps in the estimation of the time of death.
3. Rapid cooling of a dead body delays the processes of rigor mortis and decomposition.

POSTMORTEM LIVIDITY (Livor mortis) :-

Synonyms:-

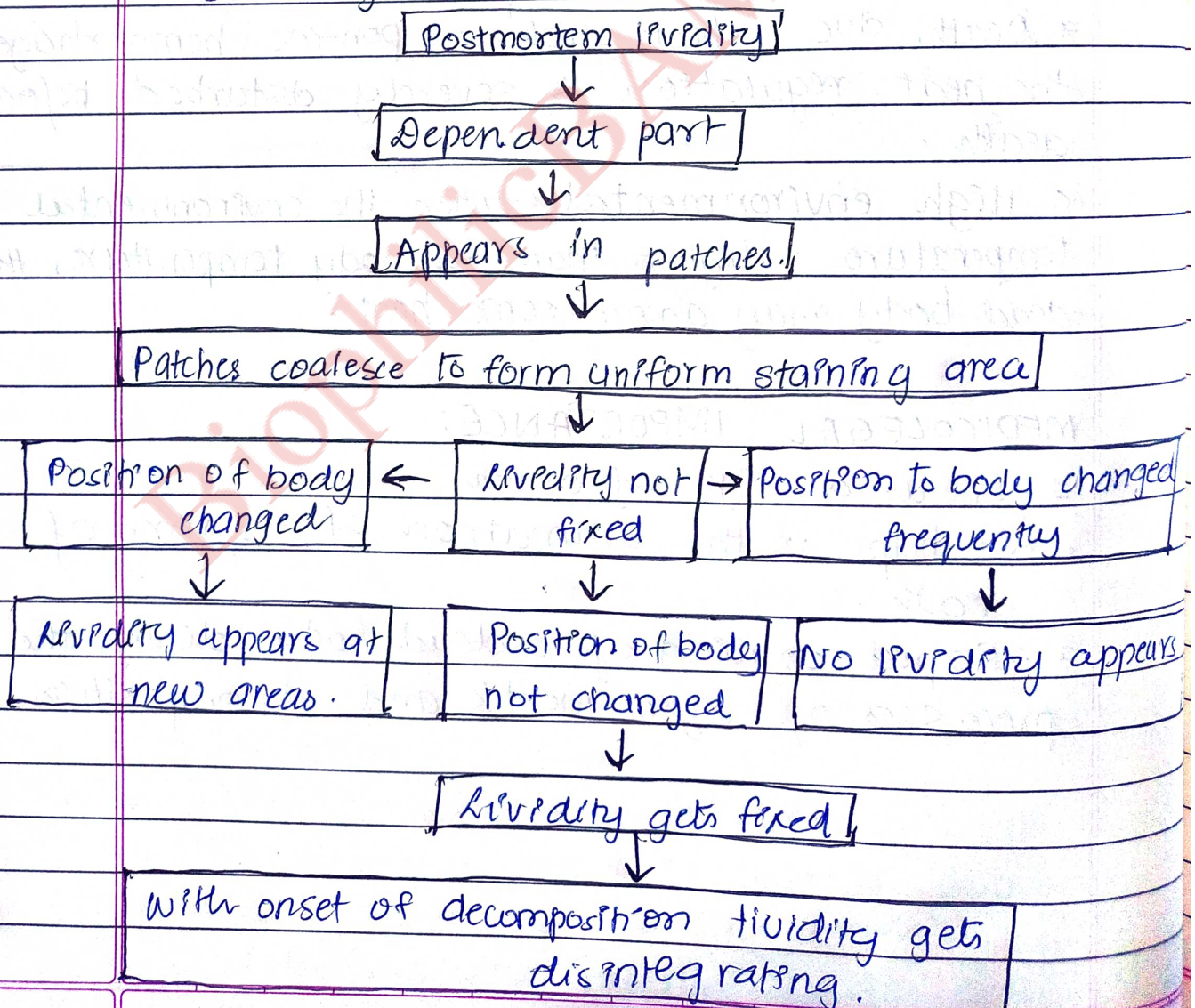
liver mortis, postmortem hypostasis, vibices, sufflation, postmortem staining.

* It is bluish or purplish-red discoloration resulting from gravitational settling of blood in the toneless capillaries and venules of the dependent parts of the dead body.

FORMATION AND SPREAD OF LIVIDITY

* Probable times of appearance of liver mortis

- half to one hour - begins to appear
- 2 hrs - seen in blotches.
- 4 hrs - spreads as a wide sheet
- 8 hrs - gets fixed



* Distribution of PM staining depends on the position of the body,
In a body lying

Supine - It appears in the neck and then spreads over the entire back with the exception of the areas directly pressed on the ground or the bed.

Prone - over front

If the body has been suspended vertically, as in hanging, postmortem staining will be most marked in the legs, and external genitalia; lower parts of forearms and hands, and upper margin of the ligature mark on the neck.

* The normal color of the PM staining is either bluish or purplish red. But in some specific causes of death, the color may be different.

Color changes:-

Cherry Red - CO (COHb)

Brick Red - Cyanide (oxyHb)

Bright Pink - Hypothermia, Refrigerated bodies

Dark brown - Phosphorus, Phosphate

Reddish brown - Nitrites, Aniline

Chocolate brown - Potassium chlorate

Green - H₂S (SulphHb).

Black - Opium.

MEDICOLEGAL IMPORTANCE:-

* It is a sign of death

* The time since death can be roughly estimated from the formation, extension and fixation of the PM staining

* It may indicate the moving of the body to another position sometime after death

* It indicates the posture of the body at the time of death.

* Cause of death may be judged from the distribution and color of PM staining.

* In the early phase of its formation, it may be confused with bruised when patchy & small.