

Infant Deaths:

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Infanticide: unlawful destruction of a child under the age of one year by anyone.
(does not include death of fetus during labor, or when it is destroyed by craniotomy or decapitation)

Feticide: killing of fetus at any time prior to birth

Neonaticide: killing of an infant within 24 hours of birth.

Criteria	Infanticide – Medical definition	Infanticide – Legal definition
Age of child	< 1 year	< 1 year
Killing done by	Anyone	Only the mother, with the provision that she must be under the effect of childbirth or lactation
Gender specificity	Person of any gender can commit infanticide	Infanticide is a gender specific law. Only a female can commit the crime of infanticide
Punishment	As for murder	As for manslaughter
Verdict passed on perpetrator	Verdict for homicide.	Verdict of homicide in India

Stillbirth: a stillborn child is one born after 28th week of pregnancy & which did not breathe or show any signs of life at any time after being completely born [WHO].

→ child was alive in-utero, but dies during the process of birth.

→ Causes:

- Anoxia
- Congenital defects
- Prematurity
- Birth trauma (especially ICH due to excessive moulding)
- Erythroblastosis fetalis
- Placental abnormalities
- Toxemia of pregnancy

Dead Birth: a dead born child is one which has died in utero & shows one of the following signs after it is completely born — maceration — putrefaction — mummification — rigor mortis — adipocere

	Stillborn fetus	Dead born fetus
Period of gestation	> 28 weeks	Any
Condition in uterus	Was alive just before the start of labor pains → died during labor in birth canal → did not show any signs of life after being born.	Was lying dead in uterus
Predominance	Seen mostly among illegitimate & immature male children in primiparae	No such predominance
Cardinal features	Signs of prolonged labor (bleeding into scalp, caput succedaneum, edema, severe moulding of head)	Any one or more of the following signs: Maceration, mummification, Rigor mortis at delivery, radiological signs.
Cause	Anoxia, aspiration, birth trauma, prematurity, strangulation on cord, toxemia.	Congenital anomaly, ABO & Rh incompatibility.

I] Maceration: degenerative change occurring in a fetus retained in utero after death

- occurs due to softening effect of soaking on solid tissues (**pulpy fetus**)
- **Earliest sign:** skin slippage (12 hours after IUD)
 - epidermis can easily be separated from the dermis by applying oblique pressure. (particularly noticeable over bony prominences)
- **24 hours:** fluid-filled bullae are formed between dermis & epidermis (skin blebs)
- **48 hours:**
 - Sweetish, disagreeable odor
 - internal fetal organs & connective tissue show increasing purple discolouration (due to hemolysis)
 - dark red-stained fluid accumulates in the serous cavities
 - deep-red appearance of amniotic fluid (**Tobacco juice**) or thick brown appearance in the event of passage of meconium.
 - ↑ volume of amniotic fluid & ↑ in α -fetoprotein levels
 - body is soft, flaccid & flattens out (due to autolysis of connective tissues)
 - Bones are flexible
 - Joints become abnormally mobile
 - Abdominal organs may show green discolouration due to leakage of bile pigments from bladder.
- **3-4 days:** umbilical cord is red, soft & smooth
- **5th day:** subcutaneous edema upto 5 mm.
- **> 1 week:**
 - meconium released into abdominal cavity through dissolving bowel wall
 - Abnormal USG appearance due to protruding autolyzed liver mass

- dystrophic calcification (in the autolyzed liver tissue)
fluid accumulation at the nape of the neck
- distortion of skull during vaginal delivery (may be mistaken for hydrocephalus)
squeezing of autolyzed brain tissue into the spinal cord & along the spinal roots
into retropleural & retroperitoneal areas

→ **Several weeks:** fading of colour to yellow-gray

- progressive loss of fluid from the fetus eventually results in \Rightarrow fetus papyraceous.
- dehydration \Rightarrow shrinkage & compaction of tissues & organs
- Rarely: extrauterine pregnancy may be retained for years \Rightarrow **Lithopedion** (calcified fetus retained in the abdominal cavity)

II] Rigor Mortis, Putrefaction, Adipocere, Mummification:

- Rigor mortis is a usual change after birth
- Putrefaction occurs if air enters the liquor amnii after death
- Adipocere (corpse wax) \Rightarrow formed by anaerobic bacterial hydrolysis of body fat
- Mummification occurs if all liquor amnii has drained out.

III] Radiological Signs of IU Death:

- Robert's sign:** earliest sign to appear \Rightarrow 12 hours after death
→ Air in aorta, pulmonary vessels or abdomen.
- Spalding's sign:** appears 2 days after death
→ overlapping of fetal skull bones (due to shrinkage of cerebrum after IU death)
- Devel's halo sign:** separation of subcutaneous fat of the fetal scalp from the cranial bones \Rightarrow seen as a halo.

Viability of Fetus: = ability of the fetus to survive outside the uterus.

→ Age of viability has not been defined in Indian law

→ Age of viability = 28 weeks according to English law (followed in India too)

→ At age of viability ⇒ pulmonary surfactant appears in the alveoli of lungs

→ ↑ surface tension of alveoli → alveoli become able to inflate.

→ When pulmonary surfactant is deficient → IRDS / HMD.

{ IRDS = Infant Respiratory Distress Syndrome }

{ HMD = Hyaline membrane Disease }

L/S ratio $< 2 \Rightarrow \uparrow$ risk of IRDS (L/S = lecithin - sphingomyelin ratio)

Live Birth: complete expulsion of fetus from its mother, irrespective of the duration of pregnancy, & who after such expulsion breathes or shows any other evidence of life.

Signs of Live Birth:

(1) Shape of Chest:

→ Before respiration: • chest is flat

• circumference is 1-2 cm less than that of abdomen at the level of umbilicus

→ After respiration: • chest expands

• dum-shaped

(2) Position of diaphragm: abdomen must be opened before thorax to note the highest point of diaphragm (if thorax is opened first → Air can enter thorax → diaphragm is pushed to a lower level giving false indication of live birth)

→ Before respiration: level of 4th or 5th rib

→ After respiration: level of 6th or 7th rib.

(3) Lungs:

	Before Respiration	After Respiration
COLOUR	Uniformly reddish brown / bluish / deep violet depending on the degree of anoxia.	Mosaic, mottled or marbled
VOLUME	Small ; lungs do not cover heart. — Lungs are collapsed on the hilum.	Larger ; lungs cover the heart.
SURFACE	Smooth	Uneven
MARGINS	Sharp	Rounded
LOWERMOST } MARGIN }	At the level of 4th or 5th rib	At the level of 6th or 7th rib
CONSISTENCY	Liver-like, dense, firm, non-crepitant	Crepitant, elastic, soft, spongy
BLOOD WITHIN } LUNGS }	Less	More (twice that present in unrespirated lung)
ABSOLUTE WEIGHT } OF BOTH LUNGS }	35g → Fodéré's test	70g
WEIGHT OF BOTH } LUNGS in relation to body weight }	1/70 of body weight → Ploucquet's test	1/35 of body weight
SPECIFIC GRAVITY	1.04 - 1.05 (Heavier than water)	0.94 (lighter than water)

		Before Respiration	After Respiration
HYDROSTATIC TEST }		- ve (sinks in water)	+ ve. Floats in water.
THORACIC CAVITY		Not occupied fully by lungs	Almost occupied fully by lungs.
PLEURA		Loose, wrinkled	Taut, stretched.
Oozing of BLOOD }		Little frothless blood exudes on pressure.	Abundant frothy blood oozes on cut-section
BRONCHI & BRONCHIOLES }		Empty	Contain blood-stained froth
ALVEOLI		Not inflated	Inflated
MLI		Indicates stillborn or dead born fetus	Indicates live born child

Fodéré's Test / static Test: lungs are ligated across their hilæ, separated & weighed.

Hydrostatic / Raygat's Test: Breathing \Rightarrow \uparrow in volume of lungs
 \Rightarrow \uparrow in weight of lungs
 $(\uparrow$ in volume $>>>$ \uparrow in weight)

→ Performed in 4 stages:

(i) Stage 1: Whole thoracic pluck (both lungs + heart) are placed in a bucket of water \rightarrow if pluck floats \Rightarrow indicates live born fetus



if pluck sinks \Rightarrow move to stage 2.

- a piece of liver is also sunk in water as control (normal liver sinks)
 $[$ if liver floats \Rightarrow indicates putrefaction]

(ii) Stage 2: Each bronchus is tied & lungs severed above the ligature

→ each lung is placed separately in water → if either lung floats



if either lung sinks



Indicates live birth



move to stage 3

(iii) Stage 3: cut each lung into 12-20 pieces → roll a piece of lung gently between thumb & index finger → hear for crackling crepitant noise

→ dip each piece under water & squeeze between thumb & finger

→ check if bubbles are escaping & if the piece floats independently

→ if not ⇒ move to Stage 4

(iv) Stage 4: each piece is taken out of water → wrap in a piece of cloth → squeeze by putting a weight → removes the expiratory reserve volume (ERV) & tidal volume (TV) [Residual volume still remains within the alveole & cannot be removed by any means]

→ residual air is responsible for keeping the lungs afloat in infants who have been born alive & respiration → if lung floats ⇒ Live birth

- if lungs were floating in earlier stages due to artefact (such as gas introduced by artificial respiration) ⇒ piece of lung would not continue to float till the last stage

Child did not respire but lung floats:

- i) artificial respiration (tube/catheter/cannula passed into mouth or trachea)
- ii) Putrefaction (distinctive features: body shows signs of decomposition, lungs are soft & greenish)

- iii) Respiration within the womb (*vagitus uterinus*) [in case of rupture of membrane]
- iv) Respiration within the vagina (*vagitus vaginalis*)

→ Hydrostatic test is not required when one is sure fetus was born alive:

- stomach contains milk
- umbilical cord has separated & a scar has formed

(4) Changes in Stomach & Intestines:

Breslau's Second Life Test / Stomach Bowel Test: stomach & intestines are removed after tying double ligatures at each end → put in water
→ if they float ⇒ respiration had taken place

- air is swallowed into stomach & intestines during respiration.
- false positives — resuscitation attempts
 - bacterial gas formation [putrefaction]

Other materials that maybe present in stomach: • amniotic fluid • blood
• meconium • milk • mucus • saliva

→ Presence of milk in stomach ⇒ surest indication of live birth

(5) Changes in Middle Ear:

Wreden's test: skull cap is removed → base of skull submerged in water
→ petrous part of temporal bone (roof of middle ear) is opened →
if bubble of air escapes from middle ear ⇒ Live birth
• reliability of this test is low

(6) Caput succedaneum: an area of soft swelling that forms in the scalp over the presenting part of the head in vertex presentations.

- starts diminishing soon after birth ⇒ completely disappears in a week
- D/d: Cephalhematoma.
- Sign of live birth

(7) Umbilical Cord Changes:

2 hours	blood clots in the cut end
24 hours	cord attached to child shrinks & dries (seen in deadborn & stillborn also)
48 hours	An inflammatory ring forms at the base of stump.
3 days	Cord mummifies (seen in deadborn & stillborn also)
5-6 days	Cord falls off, leaving an ulcer
10-12 days	Ulcer heals, leaving a scar.

(8) Circulatory Changes in a newborn:

Structure	Closure Period
Umbilical arteries	10 hours to 3 days
Left umbilical vein	3-5 days
Ductus venosus	3-5 days
Ductus arteriosus	7-10 days
Foramen ovale	2-3 months

Battered Baby Syndrome: aka Caffey - Kempe syndrome / Non Accidental Injury of Childhood (NAIC) / Taedieu's syndrome / Parent - Infant Traumatic Stress Syndrome (PITS).

- clinical condition in which young children, usually under 3 years of age, are beaten repeatedly over the most trivial provocation.
- 10-15% cases of cerebral palsy may be the result of BBS.
- Injuries are due to direct manual violence

I) External Injuries:

i) Tear of frenulum: most typical injury

- caused by:
 - efforts to silence screaming
 - blow on face
 - attempt to suffocate the child.

ii) Soft tissue injuries:

- abrasions
- bite marks
- bruises ⇒ indicate places where child was gripped strongly (six penny bawise)

- graze abrasions

- knuckle punches

- lacerations

- pinch marks

- slap marks

- scalp injuries

iii) Eyes:

- Black eye
- Lens displacement
- Retinal separation

- Retinal, subconjunctival, Subhyaloid, Vitreous haemorrhages

II) Internal Injuries:

(1) 1st Skeletal Injuries:

- i) skull fractures (especially in occipito-parietal area)

- ii) transverse & spiral fractures of long bones

- iii) Traction lesions:
 - periosteal hematomas

- periosteal shearing

- epiphyseal separation

- avulsion of metaphysis / chipping of edges of metaphysis.

iv) Anteroposterior compression of chest \Rightarrow fractures of ribs in mid-axillary line

v) Side-to-side compression of chest:

- fractures at costochondral junctions
- fractures along posterior angles of ribs \Rightarrow string of beads

Rosary bead appearance on X-rays.

(a) And Visceral injuries:

- i) SDH is found in about 40% of fatal cases
- ii) Lungs \Rightarrow Posttraumatic pulmonary pseudocysts (PTPPCs)
- iii) Liver \Rightarrow bursting injuries
- iv) Spleen \Rightarrow bursting injuries
- v) Stomach, intestine & urinary bladder may be ruptured
- vi) Second part of duodenum & jejunum may be completely transected
- vii) Tearing of mesentery

Diagnosis:

I) In the living:

- time taken to seek medical advice
- nature of injuries
- recurrence of injuries
- Imaging studies
 - X-rays of entire body (babygram)
 - MRI
 - Technetium $[^{99m}\text{Tc}]$ methylene diphosphonate (MDP) bone scintigraphy.

II) In the dead:

- Imaging studies (same as in the living)
- Autopsy (for external & internal injuries)

Cause of death:

- Head injury (most common)
- Rupture of abdominal organ (and most common)

Sudden Infant Death Syndrome (SIDS): aka Cot death/

→ sudden death of a seemingly healthy infant [< 1 y], whose death remains unexplained even after: Sudden death

- thorough case investigation
- review of clinical history
- death scene examination
- complete autopsy
- serological, toxicological, histopathological, microbiological examinations

Theories of Causation:

(1) Allergies: • cow's milk protein allergy • horse milk allergy

(2) Central Diaphragm Failure [CDF]: due to – undeveloped respiratory muscles
– non-lethal infections
– prone resting position
– REM sleep

(3) Deficiencies: Antibodies Biotin Ca, Mg, Se
Gamma globulins vitamins B, C, D, E

(4) Pregnancy factors: factors that prohibited fetal circulation → damage of fetal
(eg: cocaine use) medulla cannot control breathing properly ← brain

(5) Genetic: • brainstem abnormality of the serotonergic system
• cardiac channelopathies
• faulty IL-1 receptor antagonist protein

- left ventricular hypertrophy
- MAO-A molecular polymorphisms.

(6) Hormonal - deficiency of parathyroid

(7) Infections - respiratory

(8) Inflammatory reactions (cytokine storm)

(9) Obstruction of airways:

- Anatomical abnormalities
- Nasal edema
- Nasal obstruction/inflammation
- Excessive mucus in respiratory passages
- Flaccid pharynx in hypotonic babies
- Faulty neck posture
- Laryngeal spasm

(10) Prone sleep position: death due to -

- asphyxia due to airway compression
- re-breathing of exhaled gases in face-down position
- Impaired heat loss \longrightarrow hyperthermia
- more bacterial growth

(11) Sharing of beds

(12) Sleep apnea

(13) Sleep-induced arrhythmias

(14) Miscellaneous

- Adrenal insufficiency
- Hyperthermia
- Hypothermia
- Neurogenic shock

- Deficient liver enzymes
- Metabolic disorders

(15) Alcoholic mother: ↑ incidence of SIDS in children

→ Death always occurs in sleep.

Autopsy:

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i) Face: • Facial pallor

- No petechial haemorrhage in face/eyes

ii) Hands: • Clenched

iii) Definite pathology: (found in 15% cases) • Congenital heart disease • Down's syndrome

- Pneumonia
- Tracheobronchitis

iv) Milk or blood-stained froth: in child's nostrils/mouth.

v) Respiratory passages: • froth • milky vomit • shedding of individual tracheobronchial epithelial cells

vi) Inflammatory signs: • Laryngitis • Tracheitis • Bronchitis • Pneumonitis
Pleuritis • Bronchiolitis

vii) Lungs: • Surface - patchy/uniform purplish discolouration • Consistency - firm
• Pathology - congestion, edema

viii) Petechial haemorrhages: (most common finding)

- on visceral surfaces of heart, lungs & thymus.

ix) Histopathology: • Bronchi - peribronchiolar cell infiltration

• Lungs - patchy alveolar collapse - thickened alveolar walls
- capillary thrombosis
- aggregation of platelets, neutrophils, monocytes, lymphocytes.

x) Brain: bilateral hypoplasia of arcuate nucleus (in brainstem)

xi) Heart: resorptive degeneration of conductive system

xii) Biochemical: ↑ level of cytokines in blood & CSF [IL-1 β , IL-6, TNF α].

MLI:

→ Infanticide may be misdiagnosed as SIDS due to lack of evidence

→ Heart & other organs from SIDS infants can be transplanted in other infants with no ↑ evidence of death in recipients.