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**FORENSIC ASPECTS OF DROWNING - A REVIEW****Karandeep Somkuwar\*, Prachi Kathane, Poonam Moon & Vaishnavi Thakre**  
Govt. Institute of Forensic Science, Nagpur**ABSTRACT**

Drowning is defined as respiratory impairment from being in or under a liquid. Drowning itself is quick and silent, although it may be preceded by distress. Drowning occurs more quickly in fresh water (4-5 min) than in salt water (8-12min). In order to determine, if drowning is the sole cause of death, a complete examination of the body as well as the organs is essential. Many post-mortem findings are considered such as washer woman's appearance in palm and sole, copious leathery froth from mouth and nostrils, wet cloths etc. It is also important to rule out if the death is natural. Forensically it is very important to interpret the actual cause of death and the manner of death whether it is accidental, suicidal, or homicidal. For this findings have to be viewed along with the circumstances. Occasionally, swimmer, and fisherman may be drowned accidentally, but it is common in non-swimmers. Further for the confirmation of death due to drowning various tests are performed like diatoms identification, biochemical test, presence of middle ear haemorrhage and others. Whenever there is absence of signs or, injuries and in decomposed bodies it becomes difficult to diagnose death from drowning. This review paper deals with some of the forensic aspects of drowning.

**Keywords:** *Drowning, Biochemical test, wet drowning, Dry drowning.*

**I. INTRODUCTION**

According to the new definition adopted by the WHO in 2002, "Drowning is the process of experiencing respiratory impairment from submersion/immersion in liquid". Drowning is a form of asphyxial death in which the access of air to the lungs is prevented due to submersion in water or any other fluid medium. Complete submersion of body is not necessary as far as drowning is concerned, sufficient water to cover nostrils and mouth can also cause drowning.

The term "drowning" indicates the obstruction of air passage or lungs due to inhalation of fluid. Water is inhaled and the victim gets severe chest pain which ultimately reduces the chance of survival. Drowning may be classified as typical drowning and atypical drowning. While typical drowning is also known as 'wet drowning', atypical drowning is also known as 'dry drowning'.

Drowning may further be classified as 'fresh water drowning' and 'salt water drowning'. In fresh water drowning, large quantity of water crosses the alveolar membrane into the circulation which results into marked hypervolemia. As a result of excessive water, the red cell may swell or burst and potassium is liberated. There may be 50% dilution within two to three minutes. Thus, heart suffers from anoxia, hypervolemia, potassium excess, and sodium deficit, potassium excess and anoxia lead to ventricular fibrillation and death occurs in four to five minutes. In salt water drowning, due to hypertonicity of the water it causes loss of fluid from blood in the lungs giving rise to severe pulmonary edema. Later it progresses causing hypovolemia, circulatory shock and eventually cardiac standstill or asystole. The process takes about eight to twelve minutes.

**II. THE MECHANISM**

When a non-swimmer falls into water, he sinks due to force of fall and weight of the body. Body weight is made up of 75% water and 5% fat (specific gravity-0.92) which is lighter than water. Thus, the major portion of the body has a tendency to float and this is known as natural buoyancy. Therefore, the person rises to the surface due to natural buoyancy of his body. This is assisted by the air trap between the body and the cloth and the struggling movement of body. When a person reaches the surface, violent attempts to breathe and shout are made and at the same time some

air is inhaled into lungs. Similarly, water enters into mouth as well into air passages and then enters the stomach. The water that enters into the air passage causes violent coughing. A certain amount of air is expelled from the lungs and its place is taken up by the water which is now drowning the lungs. At this instant the specific gravity of the body is thereby raised and the body will start to sink. The continuous struggle of the body brings it to the surface again, more water enters the body and it sinks again. This is repeated several times but finally the body sinks to the bottom. By this time, consciousness will have been lost or the person may flounder aimlessly in water due to vestibular disturbance. Later, the water acts as an irritant and stimulates the secretion of mucus.

### III. CAUSES OF DEATH

Asphyxia is the most common cause of death and results due to Obstruction to the air passages by inhalation of fluid, and Laryngeal spasm due to entry of water in the nasopharynx or larynx. Other causes may include: Ventricular fibrillation is a serious cardiac rhythm disturbance which causes death in fresh water drowning. Cardiac standstill is a complete cessation of cardiac rhythm which causes death in salt water drowning. Vagal inhibition cause death due to impact with water. Hypothermia causes chilling of body which results in death. Concussion or injury to any vital organ received during falling, development of unconsciousness from any cause as for example, epileptic attack or rupture of cerebral aneurysm, Cardiac failure due to an old heart lesion, especially coronary atheroma, or from exhaustion, Secondary drowning syndrome, etc.

#### Fatal Period

Death occurs in about 5 minutes of complete submersion. Death occurs more quickly in fresh water than in salt water. It takes four to five minutes in fresh water whereas, eight to twelve in salt water.

### IV. AUTOPSY FINDINGS

The Postmortem examination of body is carried out externally and internally. The findings may be:

#### A) External Appearances

1. **Wet cloths:** If the body is recently removed from the water the cloths are wet.
2. **Fine froth:** Fine froth at the mouth and nose is pathognomonic of drowning. Fine, whitish, leathery, tenacious, copious froth is seen oozing from mouth and nostrils. This is produced by churning of air, mucus and water in the respiratory track. The presence of froth is of great importance in cases of drowning.
3. **Cadaveric spasm:** The presence of weeds, mud, sand etc. in the tightly clenched hand indicates that the person was alive when he was drowned. Presence of cadaveric spasm is considered as a sure shot sign of death due to drowning.
4. **Skin appearance:** Skin is wet, cold, clammy, and pale due to contraction of its blood vessels. Skin may show cutis anserine i.e. appearance of goose flesh or goose skin. It is a state of puckered and granular appearance of skin with hairs standing on end. It is produce by the spasm of the erector pilae muscle and is due to exposure to cold water at the time of death.
5. **Washerwoman's hand:** It is due to action of water on thickened epidermis resulting in loss of skin tone and contraction of blood vessels. There is whitening, soddening, bleaching and wrinkling of skin particularly on palmar surface of hands and soles of feet. Subsequently the epidermis gets separated from the dermis in glove and stock fashion from hands and feet. It helps in estimation of approximate duration of immersion as.
  - Wrinkling: if water is cold, skin gets wrinkled soon after immersion
  - Bleaching of cuticle: become evident after 12 hours of immersion
  - Bleaching, corrugation and soddening becomes pronounced within 24 hours
  - Cuticle begins to separate from palm and sole by 48 hours.
6. **Rigor mortis:** It appear and passes early due to exhaustion and /or violent struggle for life.
7. **Hypostasis:** In flowing or turbulent water lividity may not appear. It may be pronounced in the face, head, neck and anterior chest because the body floats partly head-down in water.
8. **Eyes:** There may be changes in the eye like suffused and congested conjunctiva. Few subconjunctival hemorrhages may be seen

## B) Internal Appearances

### 1. Changes in Lungs:

- Appearance: The lungs are voluminous, oedematous, ballooned, water lodged, bulging. The distended lung surface shows indentions of ribs. Lung feels heavy, doughy in consistency and pits on pressure by fingers. On cut section, oozes fine, copious leathery froth. In fresh water drowning, lungs retained the shape. In salt water drowning lungs are heavy, saggy, ballooned and cut section exudes copious frothy fluid and the cut section does not retain shape.
- Paltauff's hemorrhages: These are subpleural hemorrhages mostly noted over anterior surface and margins of lungs. They are caused due rupture of interalveolar partitions beneath the pleura.
- Emphysema aquosum: The lungs feel heavy, doughy, spongy and water lodged. This state is referred as emphysema aquosam. This condition indicates that the person was conscious and struggles for life.
- Edema aquosum: This condition develops when person is passively immersed with no violent effort of respiration in water or when person is unconscious. It is a state of mere flooding of lungs with the water with no formation of column of froth.
- Weight of lungs: Weights of lungs in drowning are around 600 to 700 gm whereas non-drowning lung weighs about 370 to 540 gm.30

2. **Hemorrhage in middle ear and mastoid:** This is caused due to vascular engorgement as a result of increasing pressure from surrounding water compressing the air filled cavity of the body.[4]

3. **Periorbital and conjunctival petechial hemorrhages:** These are also sometime found but are not so common. [3]

### 4. Laboratory Findings

#### Microscopy

- Lung: Pulmonary alveoli are distended. They may contain fluid with foreign material such as aquatic vegetation. The alveolar septal wall appears stretched and thinned with compression of capillaries along with some ruptured alveoli.
- Blood: Fresh water drowning- shows low RBC count with hemolysis. In seawater drowning- relative increase in RBC count with RBCs appear crenated and shrunken
- Biochemical
- Gettler test: This test is of historical importance and do not have practical importance. According to Gettler, hemodilution due to fresh water drowning reduces plasma concentration of chloride content of blood on left side of heart. A difference of 25 mg/100 ml of chloride between right and left side of heart is considered as significant.
- Strontium test: Difference of 75 µg/L of strontium concentration between right and left side of heart is considered as significant in seawater drowning.

### 5. Diatom Identification:

The diatom test is based on principle that when a living person is drowned in water containing diatoms, many diatoms will penetrate the alveolar wall and be carried to distant organs such as brain, kidney, liver, bone marrow etc.

## V. TREATMENT

Treatment should be commenced at once in the open air. The aim is resuscitation. In fresh water drowning an external defibrillator should be applied to the chest and an attempt made to restore the electrolyte balance, to make good the loss of red cells by transfusion of packed cells, to combat the hemoglobin in the plasma. In salt water drowning treatment should be aimed at administration of oxygen by positive pressure breathing and correction of hemoconcentration by infusion of hypotonic fluids. The air passages should be kept clear by repeated suction. There are two main methods-

**Artificial respiration:** It is done in two ways direct, mouth to mouth and direct mouth to nose. The patient lies on his back on a hard surface. The upper airway is cleared, his head hyperextended, and the chin raised by raising the mandible by finger pressure under its angle. The operator takes the deep breath and inflates the patient's lung about

15-20 times per minute in adult and 20-30 times per minute in small children by breathing directly mouth to nose or mouth to mouth through a specially design tube. Adequate ventilation is assessed by expansion of the chest with each inflation and by the patients colour become pink. The procedure is abandoned if it is certain that death has occurred; otherwise continued till natural respirations are restored.

**Closed-chest cardiac massage:** The object of closed-check cardiac massage is to empty the blood from the ventricles by compressing the heart between the sternum and the spinal column. This is accomplished by laying the patient on his back on a hard surface. The operator places his hand one on top of the other, on the lower end of the sternum and commences forcible rhythmic compression at the rate of 60-80 minutes. Sufficient force should be applied to produce pulsation. Both cardiac compression and mouth to mouth ventilation of the lungs can be achieved by an operator kneeling at the site of patient. If there is no signs of recovery after 15 minutes or more chances of resuscitation are less.

## VI. PREVENTIVE MEASURES

Several preventive measures may be taken to prevent or at least lessen the instances of drowning. With the help of these interventions, many deaths due to accidental drowning may be reduced. It includes: fencing of the swimming pool, covering up the wells or open barrels with grills, installation of Pool alarms, use of personal protection, ensuring the availability and use of Personal Flotation Devices (PFDs)- life jackets, increasing awareness amongst parents and guardians, providing lessons in swimming skills and Cardiopulmonary resuscitation (CPR). With this paper, we urge the concerned authorities to take steps to prevent this hazard that is being faced by a large population especially near water bodies.

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