



DROWNING AND NEAR DROWNING

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WHAT IS DROWNING?

- ***“The process of experiencing respiratory impairment from submersion/immersion in liquid ”***
- It is a form of asphyxia.
- Caused due to aspiration of fluids

Epidemiology

- Incidence of drowning- 2.5 lakhs to 3.5 lakhs every year
- India & China account for 43% deaths.
- Males > Females
- 1-4 yrs & 15-19 yrs (M.C)
- Drowning second most common accidental cause of death in children

Causes of Drowning

- CHILDREN YOUNGER THAN 1 YR :
 - • BATHTUB(71%)
 - • HOUSEHOLD BUCKETS(16%)
- CHILDREN 1-4 YR :
 - • POOL
 - • IRRIGATION DITCHES
 - • NEARBY PONDS & RIVERS.
- SCHOOL AGE CHILDREN
 - • SWIMMING OR BOATING ACTIVITIES.
 - • NATURAL WATER RESERVOIRS :
LAKES, PONDS, RIVERS, CANALS.

Causes of Drowning

- **ADOLESCENT**

- M : F = 10 : 1.

- (LIKELY DUE TO GREATER RISK TAKING & ALCOHOL USE.)

- 70 % DEATHS DUE TO DROWNING IN NATURAL WATER RESERVOIRS.

- **UNDERLYING CONDITIONS**

- EPILEPSY

- VENTRICULAR ARRHYTHMIAS

- ALCOHOL USE

- WATER SPORTS & RECREATIONAL ACTIVITIES

Classification of drowning.

- According to type of water
 - *Fresh-water drowning*: Lakes, pools, rivers
 - *Salt-water drowning*: seas (about 3% saline)
- According to water temperature
 - *Warm-water drowning*: temperatures of $> 20^{\circ} \text{C}$
 - *Cold-water drowning*: temperatures of $< 20^{\circ} \text{C}$
 - *Very-cold-water drowning*: temperatures of $< 5^{\circ} \text{C}$

TYPES OF DROWNING

- FOUR TYPES:-

- 1.WET DROWNING

- 2.DRY DROWNING

- 3.SECONDARY/NEAR DROWNING

- 4.IMMERSION SYNDROME

WET DROWNING

- Water is inhaled into lungs
- Victim has severe chest pain
- On resuscitation: no pleasant recollections
- Death occurs due to Cardiac arrest or ventricular fibrillation

Dry drowning

- Water does not enter lungs
- On resuscitation : panoramic views of past life.
- Death occurs by immediate sustained laryngeal spasm due to inrush of water into nasopharynx and larynx

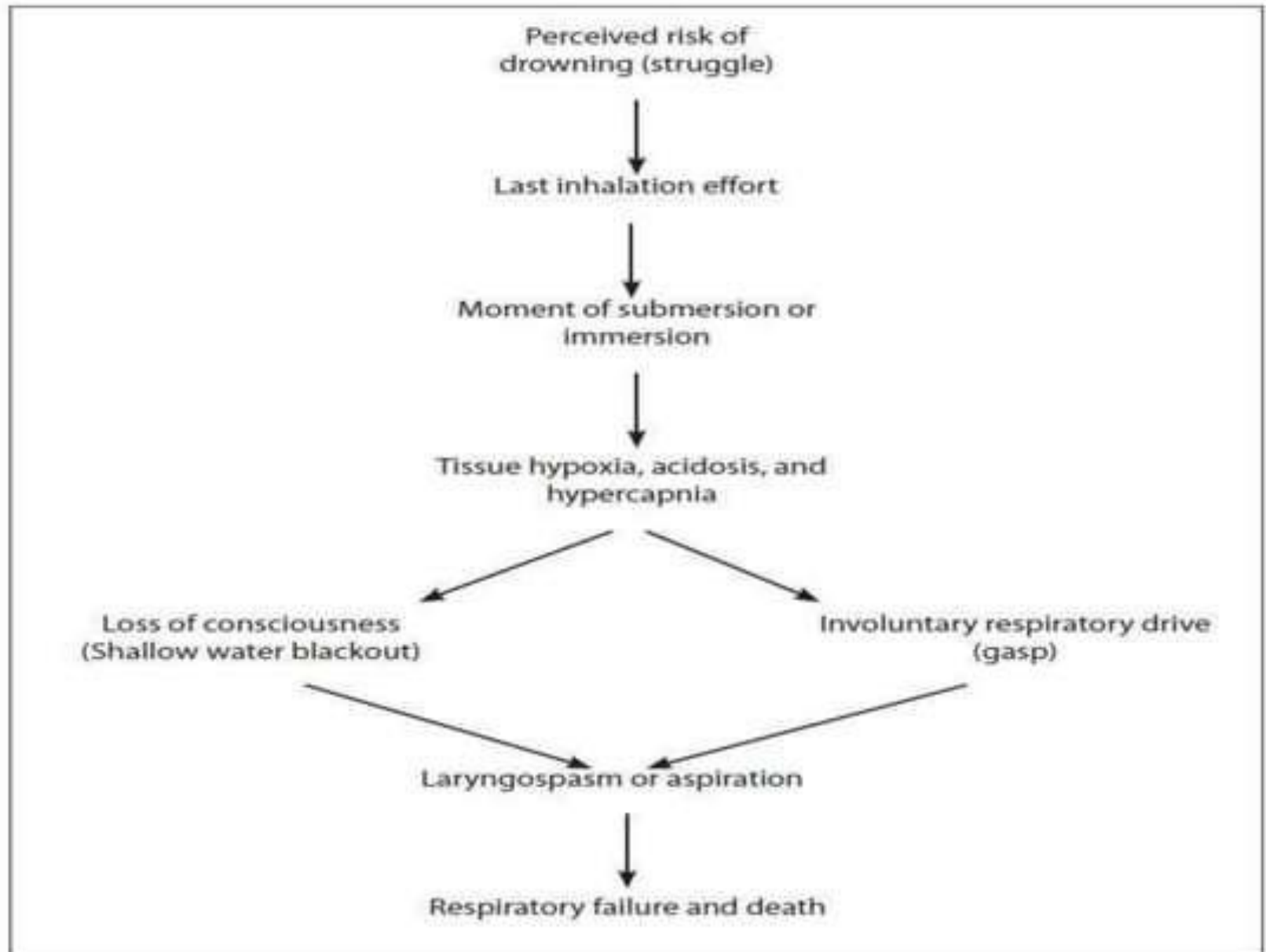
Secondary drowning (near drowning)

- Refers to a submerged victim who is resuscitated and survives for 24 hours
- Death occurs (from 1/2 h to several days) by cerebral anoxia & irreversible brain damage

Immersion Syndrome

- Death occurs by cardiac arrest caused by vagal inhibition (cold water stimulating nerve endings & water striking epigastrium & Alcohol induce such effect)
- Mostly seen in suicide cases.

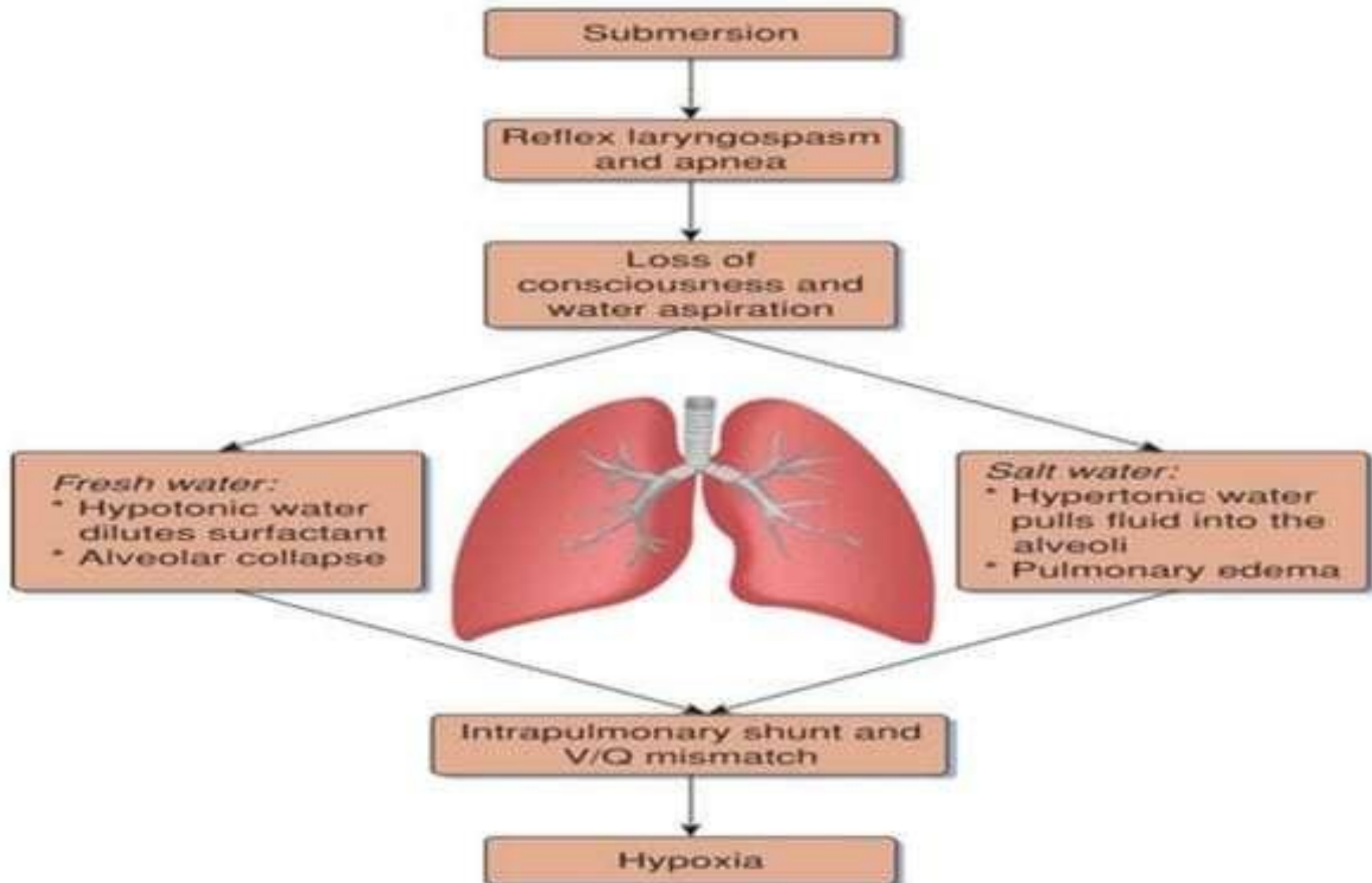
Figure 3. The Drowning Process²²⁻²⁵



Stages of drowning

- Stage of surprise(5-10 secs)
- Stage of 1st resp.arrest.(1-2 min)
- Stage of deep respiration(1 min)
- Stage of 2nd resp.arrest (1 min)
- Stage of terminal gasp.

Pathophysiology



FRESH WATER DROWNING

Hypotonic

- Water absorbed into circulation
- Surfactant washout
- Alveolar cell damage
- Chemical pneumonitis, pulmonary edema
- Hypervolemia
- Hyponatremia
- Hemodilution
- Hemolysis
- Hyperkalemia

SALT WATER DROWNING

Hypertonic

- Protein rich effusion into alveoli
- Surfactant damage, alveolar basement membrane damage
- Alveolar cell damage
- Chemical pneumonitis, pulmonary edema
- Hypovolemia
- Hypernatremia
- Hemoconcentration

Cause of death

- Asphyxia: due to airway obstruction
- Hypothermia
- Ventricular fibrillation: due to anoxia & disturbed sodium-potassium ratio
- Laryngeal spasm
- Vagal inhibition: in icy water due to high emotion & unexpected immersion
- Exhaustion
- Injury

SYMPTOMS AND SIGNS

- 75% of kids who develop symptoms do so within 7 hours of event
- Coma to agitated alertness
- Cyanosis, coughing, and the production of frothy white sputum
- Tachypnea, tachycardia
- Low-grade fever
- Rales, rhonchi & less often wheezes
- Signs of associated trauma to the head and neck should be sought
- History is the most important

EFFECT ON VARIOUS SYSTEMS

- **LUNG :**

- ARDS.
- PULMONARY OEDEMA

- **HEART :**

- MYOCARDIAL DYSFUNCTION.
- ARTERIAL HYPOTENSION.
- DECREASED CARDIAC OUTPUT.
- ARRHYTHMIAS & CARDIAC INFARCTION.

- **RENAL :**

- ACUTE TUBULAR NECROSIS
- CORTICAL NECROSIS
- RENAL FAILURE.

- **VASCULAR ENDOTHELIAL INJURY MAY INITIATE**
 - DIC,
 - HEMOLYSIS,
 - THROMBOCYTOPENIA.
- **GASTROINTESTINAL DAMAGE :**
 - BLOODY DIARRHEA WITH MUCOSAL SLOUGHING.
 - SERUM LEVELS OF HEPATIC TRANSAMINASES AND PANCREATIC ENZYMES ARE OFTEN ACUTELY INCREASED.
- **VIOLATION OF NORMAL MUCOSAL PROTECTIVE BARRIERS PREDISPOSES THE VICTIM TO BACTEREMIA AND PULMONARY INFECTIONS**

Management

- PRE-HOSPITAL MANAGEMENT
- HOSPITAL BASED MANAGEMENT
 - ED MANAGEMENT
 - PICU MANAGEMENT
 - CARDIORESPIRATORY
 - NEUROLOGICAL
 - HYPOTHERMIA
 - OTHER

Pre hospital management

- ABC's
- Initiation of ventilation is the only way to interrupt the submersion time
- C-Spine control, backboard
- IV, O₂, monitor, pulse ox
- Correction of acidosis by sodium bicarbonate
- NO HEIMLICH
- Passive Rewarming
- Rapid Transport
- All near drowning victims need evaluation at a medical facility

Grade	Symptoms Respiratory	Symptoms Hemodynamic	Treatment	Destination	Mortality (%)
0	No cough or dyspnea	Palpable radial pulses	Release at scene, Education	NO transport	0
1	Cough, normal auscultation	Palpable radial pulses	Rest, rewarm, reassure, and release	NO transport	0
2	Rales and small amount of foam	Palpable radial pulses	Oxygen via nasal cannula, observe for 6-24 hours	Transport for Observation: ED or overnight	0.6
3	Acute Pulmonary Edema	Palpable radial pulses	Oxygen non-rebreathing mask ACLS	Transport for Admission and observation	5.2
4	Acute pulmonary Edema	Hypotension	Possible ETT and fluids for blood pressure support ACLS	Rapid transport: ICU stay	19
5	Respiratory Arrest	Hypotension	Load and go. ACLS	Rapid transport ICU	44
6	Cardiopulmonary Arrest		ACLS	Rapid transport ICU	93

Adapted from Szpilman D: Near-drowning and drowning classification: A proposal to stratify mortality based on the analysis of 1,831 cases, *Chest* 112:660-665, 1997

Hospital management

- OBSERVATION 6-8 HRS
- MONITORING-VITALS
- REPEAT RESPIRATORY SYSTEM EXAMINATION AND NEUROLOGICAL STATUS
- If SYMPTOMS DECREASE AND SAO2 ACHIEVED VICTIM CAN BE DISCHARGED

Hospital management

- Management in ED
 - ABC's, with C-spine control
 - IV, O2, Monitor, Pulse Ox
 - CXR
 - ABGs
 - Electrolytes
 - Trauma workup

Acc to GCS

- GCS >12

- Oxygen to keep sat > 95%
- Observe 4-6 hours
- **Chest signs absent**
- Saturation normal
- Discharge home
- No investigation needed

- GCS >12

- Oxygen to keep sat > 95%
- Observe 4-6 hours
- **Chest signs present**
- Requires oxygen
- Deteriorates
- Admit to Monitored bed

Acc to GCS

- GCS <13
 - High flow oxygen
 - Intubation for low PaO₂
 - CXR, Labs
 - Continuous cardiac monitoring
 - Frequent reassessments

Cardiopulmonary resuscitation

- ETT INTUBATION
- ADEQUATE OXYGENATION
- FLUID RESUSCITATION-ISOTONIC FLUIDS
- INOTROPIC AGENTS SHOULD BE JUDICIOUSLY USED
- PERSISTENT CARDIOPULMONARY ARREST ON ARRIVAL ALONG WITH
 - APNEA.
 - ABSENCE OF PUPILLARY RESPONSES.
 - HYPERGLYCEMIA.
 - SUBMERSION DURATIONS >10 MIN.
 - FAILURE OF RESPONSE TO CPR GIVEN FOR 25 MIN.

NEUROLOGICAL MANAGEMENT

Group	Description	Treatment
A (alert)	Alert Fully conscious	Observe
B (blunted)	Obtunded but arousable Purposeful response to pain Normal respiratory pattern	Prevent further hypoxic damage Monitor clinical neurologic status Therapy as required for pulmonary and cardiovascular stability Normalize temperature
C (comatose)	Comatose, not arousable Abnormal response to pain Abnormal respiratory pattern	Prevent further hypoxic damage Therapy as required for pulmonary and cardiovascular stability Maintain normocapnia or mild hyperventilation Monitor core temperature Warm to 32°C (89.6°F), then allow passive warming to 37°C (98.6°F) Avoid hyperthermia
C.1	(Decorticate) Flexion response to pain Cheyne-Stokes respiration	
C.2	(Decerebrate) Extension response to pain Central hyperventilation	Monitor temperature
C.3	(Flaccid) No response to pain Apnea or cluster breathing	Consider withdrawal of support if no protection from hypothermia

HYPOTHERMIA

- Passive External
- Active External
- Active Internal
 - IV
 - Vent
 - NG/Bladder/Peritoneal

OTHER MANAGEMENT ISSUES

- ACUTE RENAL FAILURE :

- DIURETICS,
- FLUID RESTRICTION.
- DIALYSIS IF REQUIRED
- PROFUSE BLOODY DIARRHEA AND MUCOSAL SLOUGHING :
- BOWEL REST.
- NASOGASTRIC SUCTION.

- FEVER

- COMMON IN 50% CASES WITHIN 24 HRS
- PROPHYLACTIC ANTIBIOTICS ARE RECOMMENDED ONLY IF PNEUMONIA IS SUSPECTED

Table 3. Submersion and Drowning Treatment Summary

Asymptomatic

- Full vital signs, including temperature and pulse oximetry
- Chest X-ray
- Discharge with precautions or observe 4-6 hours

Mild Symptoms

- Full vital signs, temperature, oxygen prn
- Bronchodilator
- Chest X-ray, electrolytes
- Treat mild hypothermia
- Observe 6-24 hours

Moderate to Severe Symptoms

- Full vital signs, temperature, oxygen prn, telemetry
- Chest X-ray, electrolytes, CBC, coagulation studies
- Consider NIPPV or intubation with PEEP
- Volume support, treat hypothermia
- Supportive care and admission

Cardiopulmonary Arrest

- ACLS
- Post-arrest temperature management
- Consider ECMO





Thank You