PATIENT CARE THEORY 2

UNIT 10, PART 3: Environmental Emergencies:
Drowning, Diving

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Learning Objectives

- Describe the pathophysiology, predisposing factors, signs, symptoms, and management of the following:
  - Drowning
  - Diving/ Decompression illness
- Differentiate between fresh-water and saltwater immersion as they relate to near drowning
- Differentiate between wet vs dry drowning

Drowning

Caveat

- “a paramedic will not participate in water or other types of rescue operations unless sanctioned by the paramedic’s service operator” BLS Standards

Definitions

- Drowning - death from suffocation by submersion in a liquid. If death occurs within the first 24 hours of a submersion incident it is considered a drowning death
- Near Drowning - Suffocation by submersion in a liquid with at least temporary survival. Death from near drowning occurs after the first 24 hours

Wet vs Dry Drownings

- Wet Drowning - Fluid is aspirated into the lungs
  - "drown(ing) with aspiration: to die from the combined effects of asphyxia and changes secondary to aspiration of fluid while submerged"
- Dry Drowning - Fluid is not aspirated, death is thought to be due to laryngospasm and glottic closure
  - "drown(ing) without aspiration: to die from respiratory obstruction and asphyxia while submerged in a fluid medium" WHO
  - *these are post mortem findings)*

Near Drowning

- near-drown(ing) without aspiration: to survive, at least temporarily, following asphyxia due to submersion in a fluid medium
- near-drown(ing) with aspiration: to survive, at least temporarily, following aspiration of fluid while submerged (WHO)

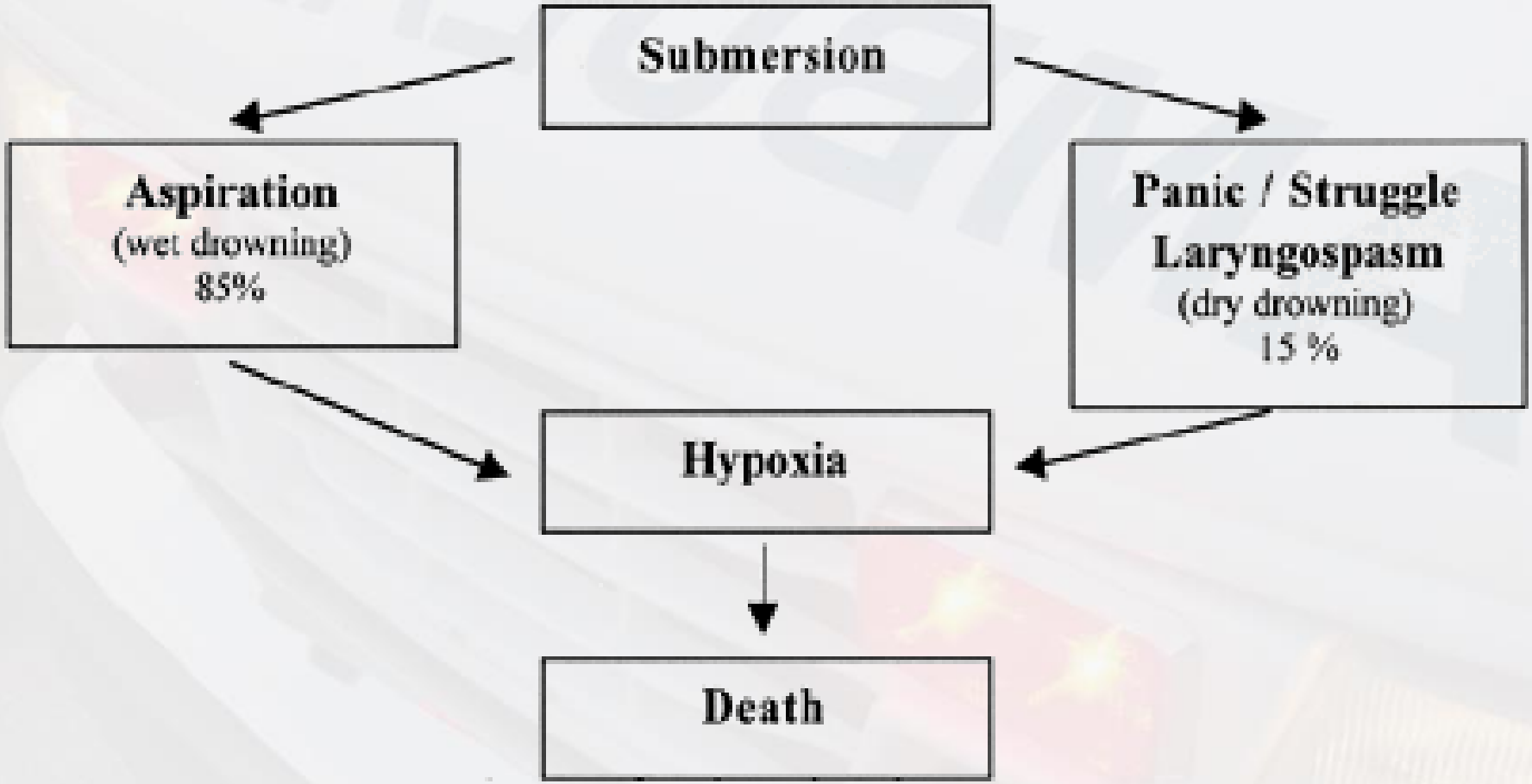
New Definition from the WHO

- "Drowning is the process of experiencing respiratory impairment from submersion/immersion in liquid.“
- drowning outcomes should be classified as:
  - Survival with no morbidity
  - Survival with morbidity
  - Death

Pathophysiology

- Panic, struggle, and breath holding.
- Rapid development of hypoxemia and hypercapnea.
- As voluntary efforts at breath holding cease, there is:
  - swallowing of water and
  - gasping with/without aspiration of water
- Large quantities of water may be swallowed and vomited leading to aspiration of gastric contaminants

Pathophysiology



Fresh-water vs Salt water

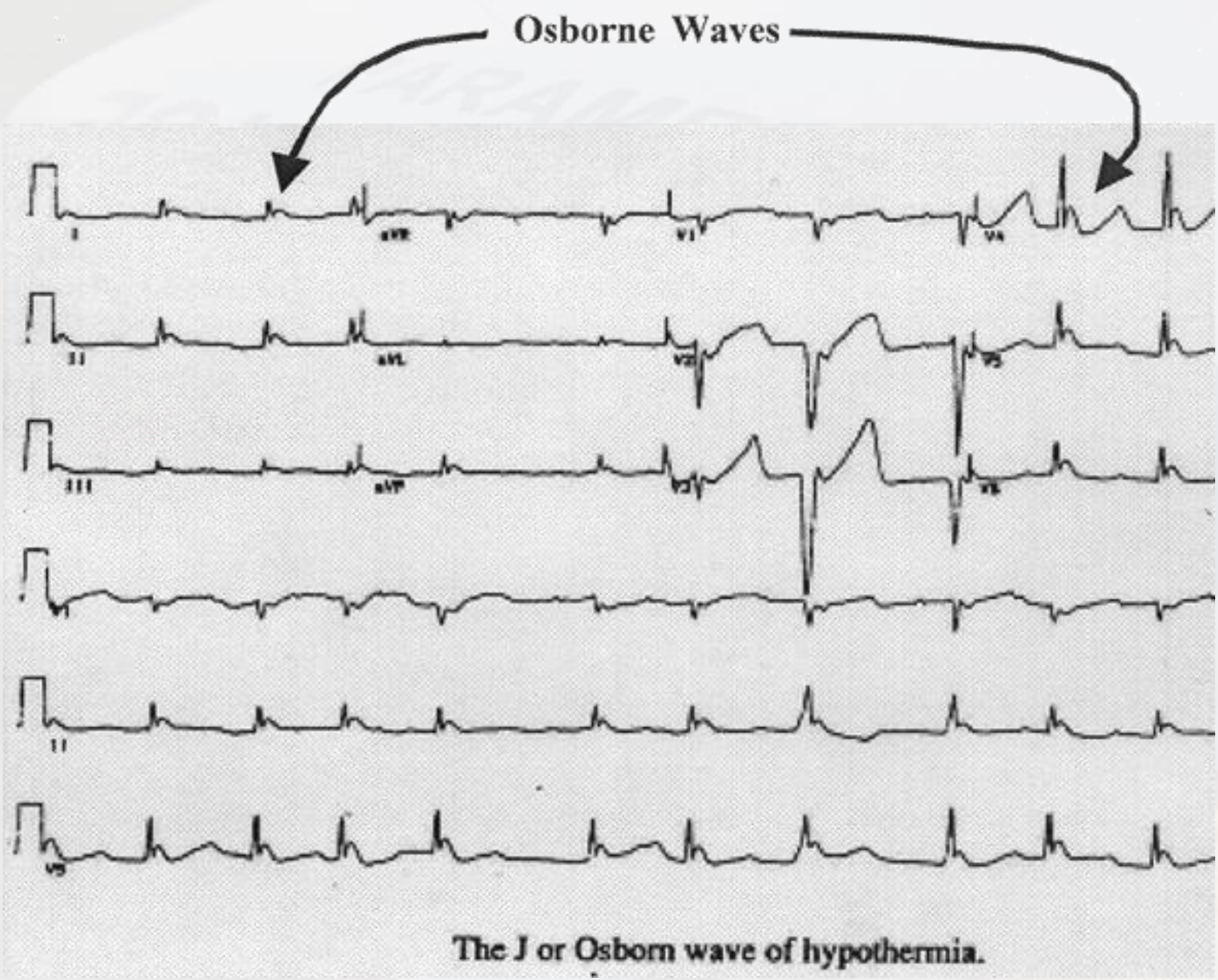
- Fresh-water
  - Hemodilution: as large amounts of hypotonic water diffuses across alveolar/capillary membrane into the vascular space
    - Reduces blood cell concentration
    - Inflammation of pulmonary tissue -> bleeding, inflammation and destruction of surfactant -> pulmonary edema and atelectasis
- Salt-water
  - Hypertonic water causes water to shift from the bloodstream in to the alveoli
    - Pulmonary edema -> profound shunting

Pathophysiology

- Respiratory and metabolic acidosis occurs from hypoxia and anaerobic cellular activity.
- freshwater and saltwater will dilute/ washout surfactant leading to atelectasis
- destruction of the alveolar capillary membrane
- ventilation/perfusion (VQ) mismatch/ shunting

Pathophysiology

- SVT is common and may simply occur from hypoxia or a massive catecholamine release.
- Hypothermia may produce Osborne Waves on the ECG
  - small notch on the descending R-wave



The J or Osborn wave of hypothermia.

Pathophysiology

- In cold water, the diving reflex may account for cardiovascular collapse.
  - It takes approximately 25 seconds for the mammalian diving reflex to work in adults and 45 seconds in children under 5 years old
- The lowest documented resuscitation temperature is 18°C to 20°C.
- Arrest seldom occurs from ventricular fibrillation except in cases of significant hypothermia (core body temperature <28 degrees C).
- CNS damage is caused by hypoxia and ischemic changes

Pathophysiology

- CNS damage mitigated in patients given CPR and in those who are hypothermic due to its protective effect on the cerebral metabolism.
- Severe neurologic damage occurs in up to 15 to 20 percent of near drowning (drowning with morbidity) patients

Pathophysiology

- Secondary drowning
  - Death caused by respiratory failure commonly from ARDS, pulmonary edema, or aspiration pneumonia that occurs following successful resuscitation.
  - Secondary drowning can occur from hours to several days after the near drowning event.

Prognosis

- **Age** of the patient - the younger the better the prognosis
- **Length of submersion** - the shorter the better
- **Colder** water = better chances of survival
- CPR - if applied early and appropriately improves survival
- **Water Quality** - the cleaner the better the survival
- **Struggle** - the more struggle the worse the results
- **Other injuries** - burn, blast, fractures reduce the survival

Pediatric

- Children have increased survivability in cold water submersion due to Mammalian Diving Reflex
  - Mammalian Diving Reflex more prominent in children
  - decreases metabolic demands
  - prevents/delays severe cerebral hypoxia
- In very cold water (specifically ≤ 20°C) the effect of cold water is more powerful
- decreases metabolic demand by half
- S/S: Coma, fixed and dilated pupils, cyanosis

Immersion Syndrome

- Sudden Immersion leads to VF

Management

- ABCs with C-spine precautions prn
- O_2 (warmed – e.g. hot packs around tubing)
- PPV prn
- 10-15 second pulse check if hypothermia
- For survivors, elevate head 30 degrees (if c-spine ok)
- Be prepared to deal with ***emesis***, agitation, seizures, cardiac arrest
- CPR prn
- Note: transport all post-drownings even if asymptomatic

Post-resuscitation complications

- Patients require close monitoring following any resuscitation
- Complication include ARDS/ pneumonitis/ renal failure
- May develop sever complication even when initial symptoms appear minor (or asymptomatic)
- Any patient that has or was suspected of being submerged for any amount of time should be transported for evaluation

Diving Emergencies

Diving/Decompression Illness

- Can occur on the surface or at any depth in the water
- More serious injuries usually follow a dive
- Related to the behaviour of gasses that are dissolved in blood
  - “weight” of gasses and the pressure they exert

“Law’s”

- Boyle’s Law
  - The volume of gas is inversely proportional to its pressure if the temperature is kept constant
- Dalton’s Law
  - The total pressure of a mixture of gases is equal to the sum of the partial pressures of the individual gases
- Henry’s Law
  - The amount of gas dissolved in a given volume of fluid is proportional to the pressure of the gas above it

Diving Injuries

- **On the surface**
  - Entanglement of lines
    - Panic, fatigue ->drowning
  - Cold water
    - Shivering and blackout
  - Boats

Diving Injuries

- **During Descent**
  - Barotrauma – injury caused by changes is pressure
    - Must equalize pressure between the nasopharynx and the middle ear through the Eustachian tube
      - Ear pain, ringing in the ears, dizziness, hearing loss, ruptured ear drum
      - Sinuses can also be affected; frontal headaches facial pain

Diving Injuries

- **On the bottom**
  - Nitrogen narcosis
    - A state of stupor that develops during deep dives due to Nitrogen's effect on the cerebral function; also called "raptures of the deep"

Diving Injuries

- During Ascent
  - Barotrauma (same as during descent)
  - Decompression Illness
    - Anything below 12 metres requires a slow ascent
  - ***Dissolved gas in the tissue may evolve too quickly if the diver ascends too quickly***
    - Creates air bubbles in tissues
    - Leads to the “bends”
    - Bubbles may migrate to the bloodstream
    - Nitrogen emboli may form
  - Pulmonary overpressure
    - breath holding -> air in lungs expands during ascent -> if not released leads to alveolar rupture ->
      - AGE (arterial gas embolism)
      - Pneumomediastinum
      - Pneumothorax

Diving Injuries

- History – The history is very important
  - Onset of symptoms
  - Type of breathing apparatus used
  - Protective garments worn
  - Parameters of the dive (depth, # of dives, duration of dives)
  - Location (eg, ocean, lake, river, quarry, or cave)
  - Aircraft travel following a dive (?)
  - Rate of ascent
  - Experience level
  - Significant occurrences during the dive: Approximate times spent at specific depths
  - Previous injuries? Decompression illness?
  - Medications, alcohol?

Diving Injuries

- Signs and Symptoms
  - Joint and abdominal pain
  - Fatigue
  - Paresthesia
  - CNS disturbances
- Management
  - ABCD
  - High-concentration O2
  - Position supine
  - IV fluids prn
  - If decompression illness or barotrauma is suspected, transport to location equipped with hyperbaric chamber

Hyperbaric Chambers

- Ontario Locations

Diving Injuries

- Take home –
  - Consider all symptoms of air embolism and decompression illness together.
  - Early assessment and treatment are more important than identifying the exact problem

QUESTIONS?