Submersion Injuries and Near Drowning
Objectives

- Epidemiology
- Fresh water vs Salt water
- Potential injuries
- Treatment
“Drowning”

- Terminal outcome (death) from a submersion event
  - A process resulting in primary respiratory impairment from submersion or immersion in a liquid medium
“Submersion Injuries”

- **Submersion Injuries (non-fatal drowning):**
  - survival, at least temporarily, after suffocation in a liquid medium

- “Near-drowning” No longer used
Only three possible outcomes

- Death
- Survival – no morbidity
- Survival – with morbidity
Epidemiology

- Disease of YOUTH
  - 64% of deaths are below 30 years
  - ¼ of all deaths are below age 5
- What gender?
  - 4:1 Male
- Drugs/ETOH on board?
  - Assume until proven otherwise
Who is at risk?

- People who:
  - cannot swim
  - overestimate their ability

- People engaging in:
  - Risk taking behavior

- Peds with inadequate supervision

- Patients suffering from:
  - Trauma, seizure, CVA, cardiac complication
Pathophysiology

- Breath holding during initial struggle
- Attempt to inhale (under water) results in laryngospasm
- Usually little or no fluid in lungs (30ml?)
- Water may enter:
  - BEFORE laryngospasm
  - After unconsciousness
Definitions

- ARDS
  - Adult Respiratory Distress Syndrome
- Ventilation Perfusion Mismatch
  - Is all the blood in the lungs being exposed to ventilatory air/oxygen?
- Pulmonary Shunting
  - Area of the lungs with perfusion but no ventilation
Submersion Injuries

Fresh water

Surfactant is destroyed

Alveolar instability

Atelectasis & ↓ Compliance & Bronchospasm

V/Q mismatch

Hypoxia

Salt water
Pathophysiology

Aspiration: 1-3 mL/kg
Destroys pulmonary surfactant
(decreased lung compliance)

Alveolar collapse,
Non-cardiogenic pulmonary edema (ARDS),
Intrapulmonary shunting,
ventilation/perfusion mismatch
Organ System Outcome

- Profound hypoxia
- Respiratory acidosis, ARDS

  ➔

- Cardiovascular collapse
- Neural injury

  ➔

- .... Death
Cold Water drowning

- “Immersion Syndrome”
- Sudden Syncope
  - Secondary to cardiac dysrhythmias on sudden contact with water
  - at least 5°C < body temp.
Cold Water Immersion Syndrome

- QT prolongation & massive release of catecholamines plus vagal stimulation
  - $\Rightarrow$ VF & asystole
- Resultant ALOC leads to drowning
Salt vs Fresh water

- Historically felt to affect electrolytes, fluid shifting, and RBC hemolysis
- Intravascular abnormalities do not occur until more than 11 mL/kg aspirated
- Most victims aspirate less than 4 mL/kg
Salt Water vs Fresh Water

- Review of 91 submersion victims
  - No victims required treatment for electrolyte imbalances

No significant clinical difference between the two!

Chlorine water not a consideration

Sewage or industrial chemicals are a hospital consideration
Case

- 18 y/o male
- Boating with friends who report patient consumed “3 beers”
- Fell off boat, submersion x 3 min
  - Per intoxicated/HBD friends.
- Brought to boat by friends, rescue breathing started immediately
  - Patient was apneic/agonal respirations
- What are your concerns.
“3 beers, man”

- What is your index of suspicion?
- What injuries/complications would you expect?
- BLS treatment?
- ALS treatment?
- What would the patient look like? Sound like? (lung sounds, skin signs, etc)
Interventions

- Immediate Rescue Breathing (even before out of water)...
  - Bystander CPR (may be in progress)
    ABC before CAB!!
- What’s the causative issue here?
  - Remove wet clothing,
  - passive external rewarming
  - Be on the watch for hypothermia
  - Is there a reason to suspect trauma?
Patient Positioning

- Resuscitation may have begun on a sloped area
  - Boat ramp?
  - Beach?
  - River bank?
- You don’t want blood to collect at head or feet
  - Position patient perpendicular to slope
Other Considerations

- CPR in the water?
  - Not effective Get victim to hard surface
- AED?
  - The arrest is hypoxic V-fib is uncommon
- Spinal immobilization?
  - Yes if history of diving, boating, surfing
  - ROUTINE spinal precautions unnecessary
Hypothermia: Good or Bad??

- Lowers cerebral metabolic rate, neuroprotective
- Diving reflex: shunting of blood centrally in response to cold water stimulus
- Causes bradycardia & apnea, decreased metabolic consumption
- Prolonged duration of submersion better tolerated
- Risks of malignant dysrhythmias
Factors associated with poor outcomes

- > 10 min submersion
- CPR initiated >10 min after rescue
- Severe acidosis (pH < 7.1)
- Unreactive pupils
- GCS = 3 (comatose)
- Need for ongoing CPR
- Lack of spontaneous movement at 24hrs
- Hypothermia in ED?
  - This is still under research
Factors Predicting Death

- Submersion > 10 min
- CPR > 10 min
- Resuscitation > 25 min
- Water temp > 50 degrees F
- Age (< 3 years)
- GCS < 5
- ABG < 7.1 in ED
Pronounce at scene?

- Rigor and lividity
- Submerged greater than 1 hour
- No response after 25 minutes of CPR
  - Remember CPR in an ambulance is NO CPR
- However . . .
  - They are not dead until they are warm & dead . . .
Can they be released on scene?

- Local protocols may dictate transport
- Lifeguards commonly asked to make decision
- Patient may want to AMA
  - Recreation situation . . .
Mortality based on symptoms

- Cough, no foam at mouth 0%
- Small foam mouth & nose + rales 0.6%
- Large foam good B/P 5%
- Large foam LOW B/P 19%
- Respiratory arrest 44%
- Cardiopulmonary arrest 93%
Emergency Department Evaluation

- ABC’s
  - Early airway management
- Monitor:
  - Hemodynamics
  - Core body temperature
- Rewarming
  - Passive External
  - Active External
  - Active Internal
CXR on arrival . . .
4 hours later....
Prevention

- Lifeguards (supervision of children)
  - Education about water rescue
- Life safety for home with pools
- Sober water sports and boating!
- Personal Flotation Devices!!!!
- Be even more concerned about patients with a history of CAD, DM, seizures
Submersion Injuries: Overview

- Rescue and Resuscitation!
- High index of suspicion of
  - trauma, alcohol, drugs
- Pulmonary insult may develop over time, keep a high index of suspicion
- No clinical difference between salt & fresh H₂O
Submersion Injuries: Overview

- Majority of treatment is supportive
  - Maintain body temp
  - Watch for lung injury progression
- Asymptomatic victims will be monitored in the ED 6-8 hours before discharge.
Keep safe!

Lay rescuers of drowning victims are at extremely high risk of drowning while performing the rescue.