Pediatric Submersion Injuries

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Objectives

• Provide an overview of current concepts in pre-hospital, ED and inpatient management of PSI patients
• Discuss recent changes in terminology
• Discuss prognostic factors in the critically ill PSI patient
Terminology

- Submersion
  - airways below surface of liquid
- Non-fatal drowning
  - Submerge -> lose consciousness -> Survive
- Fatal drowning
  - death
- Avoid “near-drowning”
Epidemiology

- Second leading cause of pediatric accidental death
- 4000 deaths per year by drowning in US
- Males : females
  - 4:1 ratio
- Highest incidence
  - 4yo and under
  - 15-18 years
Case 1

• 10 month old boy at a large pool party, falls in and he is seen floating in the pool face down with non-vigorous movements. When pulled out of the water he cries within a few seconds. Upon EMS arrival the child is alert with normal color and is without labored breathing, pulse ox 98%.

• What should be done next?
• Transported to ED with supplemental oxygen but no other intervention
• In ED lungs clear and non-labored, good color, alert and appropriate, pulse ox 98%, no PMH
• Diagnostics?
Diagnostics

• CXR?
  – *Clinical assessment should drive management*
  – *Does not tend to change management*

• Disposition?
Observation

• Delayed respiratory symptoms
  – *May develop up to 6 hours after incident*
  – *Any drop in oxygen saturation, increase in respiratory rate then admission indicated*

• Discharge home if no clinical findings after 6 hours
Case 2

• 10 year old boy pulled from water unresponsive, given two rescue breaths and began to breath spontaneously. Upon EMS arrival GCS 13 spitting up watery froth and coughing having labored breathing, Pulse ox 80%, pulse 130, BP 100/50, diffuse wheezing on auscultation.

• Pre-hospital care?
Pre-hospital care

- Oxygen via NRBM
- Suction as indicated
- glucometer
- IV access

- Upon ED arrival GCS 14- sats 91% on NRBM
Diagnostics

• ABG
  – Hypercarbic or hypoxic
  – Metabolic or respiratory acidosis

• CXR

• Glucose- if GCS <15 check glucose

• Therapy?
Therapy

• NIPPV?
  – *Improves VQ mismatch and hence oxygen delivery*

• Albuterol?
  – *Bronchospasm is common, typically will respond*

• Antibiotics?
  – *Not indicated, no benefit*
Inpatient care

• Salt water (1-2% of submersion incidents)  
  – no difference in management
• Pneumonia- consider fresh water pathogens
• ARDS-standard management
• Prognosis is generally good
Case 3- El Paso, TX

- 3 year old male falls into backyard pool in winter after gate left open, found pulseless and apneic, last seen 45 minutes ago.
- Bystander CPR
- EMS arrives
Pre-hospital care

• Is child dead?
• Resuscitation 2011
  < 6°C resuscitate if < 90 minutes
  > 6°C resuscitate if < 30 minutes
• Defibrillation?
  – Indicated x 1 per 2010 AHA guidelines
  – Subsequent shocks unlikely to help until warm
  – only need to dry off area where pads placed
• Rewarm?
  – Yes, remove wet clothes
• Postural drainage?
  – No
• Epinephrine?
  – “reasonable to consider” per 2010 guidelines
ED management

- Pt arrives in ED with HR 120 and BP 90/60 and GCS 3, rectal temp 30°C, intubated
- Rewarm?
  - Yes to 32°-34°C or fully rewarm
  - Maintaining hypothermia for 12-72 hours possibly of benefit
Hypothermia

• Children have greater BSA and will cool more rapidly in cold medium
• Brain will have
  – Decreased metabolic demand
  – Decreased edema
  – Decreased release of neurotoxic substances such as dopamine and glutamate
ICU management

- In hypothermia, plasma volume can decrease 25% due to endothelial leakage and cold diuresis
- BP may drop due to intravascular volume depletion
  - IV fluids before pressors
- ARDS ventilator management
- Social support to family
Novel Therapies

- Surfactant replacement
- ECMO in hypothermic non-fatal drownings
- Maintaining hypothermia
Prognosis

• Neurologically intact on arrival = good prognosis
• Post-arrest prognosis
  – 10% survive with severe neurologic sequelae
  – Very hard to prognosticate in first 24 hours
Poor prognosis

• Submersion > 10 minutes
• Time to CPR > 10 minutes
• Resuscitation duration > 25 minutes
• Water temp > 50°F
• Age < 3
• GCS < 5 in ED
• CPR in ED
• pH < 7.1 on initial ABG
Caveats

• Consider trauma in appropriate cases
  – *No routine c-spine immobilization*
  – *0.5% of children had c-spine injury and all had evidence of head/neck trauma and suspicious mechanism (diving/MVC)*

• Consider need for CPS
Prevention

- Secure fencing could decrease swimming pool drowning by 80% in the US
- Drowning Prevention Coalition of El Paso
  – Awareness