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IN A BLINK OF THE EYE.....PEDIATRIC SUBMERSIONS

Objectives

- Define submersion
- List age groups commonly @ risk for submersion injury
- Outline prehospital management
- Discuss possible therapeutic strategies, including hypothermia
- Recall clinical signs associated with high mortality

Submersion Terms

- Not based on consensus
- Inconsistent use - terms fail to reflect different severity and relationship to outcomes
- Imprecise - not based on simple, readily applied assessments
- Need for Uniform Definitions and Reporting

Common Terms

- Drowning – submersion victims who fail to regain or maintain a pulse and respirations after initial resuscitative measures
- Near Drowning- victims of submersion who survive more than 24 hours, but only if active interventions needed for submersion complications

Pathophysiology of Drowning

- Submersion
- Panic and flailing (if conscious)
- Inhalation and aspiration or laryngospasm
- Hypoxia
- Cardiopulmonary arrest

Complicating Factors

- Spinal cord injury
- Hypothermia
- Panicking
- Syncope
- Seizures

Confounding Other Terms

- ◉ Immersion Syndrome – sudden death after *immersion* (not submersion) in very cold water, probable vagal-stimulated arrhythmia
- ◉ Cold water immersion – (often confused with immersion syndrome) water temp less than 25C or 77F....causes hypothermia and submersion secondary to hypothermia (ie swim failure)

Dry-drowning

- ◉ Disputed by experts
- ◉ Event without significant aspiration
- ◉ Found in less than 10% of drowning victims who go to autopsy
- ◉ Laryngospasm blocks water passage into lungs
- ◉ Coughing may be critical sign

Wet-drowning

- ◉ Significant aspiration occurs
- ◉ Large amount water enters lungs
- ◉ Unsure if occurred due to efforts or passively post death
- ◉ Distinction between wet and dry has little/no clinical significance

Salt versus Fresh Water

- ◉ Salt (10%) Fresh (90%)
- ◉ *No significant electrolyte abnormalities*
- ◉ No difference in treatment
- ◉ Differences in bacteria, chemical composition (chlorine), and temperature of aspirated water more significant

Submersion Event (aka *drowning* event)

- ◉ *Pathophysiological Continuum*
- ◉ Head (or airway) becomes covered or stays covered with liquid
- ◉ Duration sufficient to pose hypoxia risk
- ◉ Aspiration into airway structures to a degree that induces coughing

Cough may be Critical: Proposed Grading Algorithm

Grade - Clinical Findings	% Mortality
◉ 1. some coughing/nl auscultation	0
◉ 2. coughing/abn ausc/rales one side	0.6
◉ 3. coughing/abn ausc/rales/ok BP	5.2
◉ 4. coughing/pulm edema/ low BP	19.4
◉ 5. no spont resp/pulse present	44
◉ 6. cardiopulmonary arrest	93

Pediatric Submersions

- 7-8000 reported US cases/ year
- 40% children 0-5 years old
- 1% of pediatric ICU admissions
- Male predominance
- Backyard pools
- Lack of supervision, ? seizures

Toddlers

- Toilets
- Bathtubs
- Buckets



Sobering pediatric stats....

....100% Mortality

- Submersion longer than 25 minutes
- Resuscitation longer than 25 minutes
- Pulseless on ED arrival

Predicting outcome

- Field initial ecg = Vf/VT 93%
- Pupils fixed unresponsive ED 89%
- Severe acidosis in ED 89%
- Resp arrest after arrival ED 87%
- Victims never regained consciousness, remaining comatose @ scene and at hospital 100%

Hospital Management

- Supportive
- Manage ARDS
- Risk of Pneumonia
- Sepsis may need pressors
- 48 hour window

Pulmonary Injury

- Contaminated foreign material
- Particulate matter
- Bacteria
- Vomit
- Chemical irritants

Pulmonary Support

- O2
- Intubation and Ventilation
- PEEP
- ?Antibiotics
- New ventilation techniques
- ECMO
- Liquid Ventilation
- ?Surfactant Therapy

Hypothermia

- Water conduction of heat
- Pulmonary heat exchange
- Cold water absorption
- Water temp possible factor in fresh water events
- Symptoms vary with degree of hypothermia
- Destructive or protective?

Rewarming

- Passive External
- Active External (beware of afterdrop)
- Active Internal
 - IV
 - Vent
 - NG/Bladder/Peritoneal
 - Bypass

Mammalian Diving Reflex

- Seen in cold water
- Vasovagal response
- Bradycardia
- Vasoconstriction
- Shunting
- Oxygen sparing



Prehospital Management

- ABC's
- Heimlich not indicated
- Aggressive airway/ventilation to interrupt submersion effects (ETT, CPAP/PEEP)
- Consider SMR, backboard
- ACLS algorithms, asystole usual
- Address H's especially!!

Prehospital Management Cont.

- Passive rewarming
- Rapid transport
- All submersion victims need evaluation at a medical facility
- Risk of flash pulmonary edema
- Don't forget : good history is important

Length of Submersion... Death/Severe Neurologic Outcome

- ◉ 0 to under 5 minutes = 10%
- ◉ 5 to under 10 minutes = 56%
- ◉ 10 to under 25 minutes = 88%
- ◉ 25 minutes = 100%

But it was Cold Water.....

- ◉ Immersion in cold water results in submersion with hypoxia, not protective central hypothermia
- ◉ Protective hypothermia in submersion exaggerated
- ◉ Possible if severe hypothermia (core temp under 30C/86F) & body cooling preceded submersion hypoxia
- ◉ Rare anecdotal reports of young children in icy water.....

Reduction Strategies

- ◉ Infants
 - Caregiver vigilance
- ◉ Toddler
 - Pool fencing
- ◉ Adolescent/Young Adult
 - Control Alcohol/Drug Use
 - Swimming lessons
- ◉ Elderly
 - Same as infant/toddler
- ◉ CPR Training!!!

Miracles Occur... *Occasionally*

- ◉ Matthew Granger
 - 14 month old
 - 20-40 minutes
- Pediatric "drowning proofing" unproven & discouraged by AAP



Only definitive therapy for submersion events is PREVENTION

