Management of Pediatric Drowning

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Goals
- Review the epidemiology of pediatric drowning in Washington State
- Discuss rescue and management strategies: on scene and in the hospital
- Identify predictors of outcome or prognosis
- Discuss the important role of drowning prevention.

What is drowning?
- "A process resulting in primary respiratory impairment from submersion or immersion in a liquid medium"
- can be fatal or non-fatal
Unintentional Injury Death per 100,000 per year
Washington State | 2004 - 2013

Unintentional Drowning Deaths by Age Group
US Data 2009 - 2013

Death Rates per 100,000 per year
Female  Male

Uninentional Injury Death - US Data 2013

Drowning  MV Occupant  Pedestrian
Drowning Rate by Age - US Data 2009-2013
(per 100,000 per year)
- Non-Fatal
- Fatal

Body of Water – Pediatric Fatal Drownings
Washington State 1999 - 2003

Unintentional Drowning Rates by Age Group
WA 1997 - 2011
Chain of Survival

- Prevent Drowning
  - be safe in and around water
- Recognize Distress
  - ask someone to call for help
- Provide Flotation
  - to prevent submersion
- Remove from Water
  - only if safe to do so
- Provide Care as Needed
  - seek medical attention

Initial Medical Care

- ABC – not CAB
  - Position parallel to shore – do not need to clear lungs
  - 85% will vomit during resuscitation
  - Check pulse after 5 effective breaths
- Most common non-perfusing rhythm is asystole
  - AED less helpful
- But… most victims will not need care
Priorities in Care

- Ventilation most important initial treatment for victims of submersion. Rescue breathing should begin as soon as the rescuer reaches shallow water or a stable surface.
- Pulses may be weak / difficult to palpate in hypothermic patient with sinus bradycardia or atrial fibrillation; search for pulses should be performed for at least one minute before initiating chest compressions in the hypothermic patient because many dysrhythmias require no immediate treatment.
Care of the Asymptomatic Patient
- Observe for approximately 8 hours and admit if any deterioration occurs.
- If vital signs, pulse oximetry, and all studies, including CXR obtained at end of observation period, are normal, the patient may be discharged with appropriate follow-up.

Controversies in Outcome & Prognosis
- Occult trauma
- Salt vs fresh water
- Water temperature and survival

How Common is Occult Trauma?
- When do you need to protect the neck?
- King County (1974-1996):
  11 (0.5%) of 2,244 submersion victims had C-spine injuries. All 11 had submerged in open bodies of water; were >15 y/o; had clinical signs of serious injury; and had a history of diving, motorized vehicle crash, or fall from height.

J Trauma. 2001;51:658–662
How Common is Occult Trauma?

- When do you need to protect the neck?
  0 of 50 pediatric submersion victims had C-spine injuries.
  Four had other traumatic injuries: MVC x 2, fall from height into water; propeller injury.

Routine C-spine immobilization does not appear to be warranted solely on the basis of a history of submersion.

According to the 2010 AHA Guidelines for Advanced Cardiac Life Support (ACLS), routine cervical spine immobilization can interfere with essential airway management and is not recommended.

Is it Better to Drown in Fresh Water?

- Theoretical risk of salt water drawing fluid into pulmonary interstitium causing pulmonary edema and intravascular depletion with hypertonic serum.
- Aspirated fresh water thought to be rapidly absorbed, with resultant volume overload and dilution of serum electrolytes.
Is it Better to Drown in Fresh Water?

- In the lab, need to aspirate > 20 mL/kg before volume & electrolyte changes occur.
- Most non-fatal drowning victims aspirate only 3-4 mL/kg.

Distinction is likely unimportant – at least, in patients surviving to medical care.

Is Cold Water Protective?

- Theoretical benefit of rapidly cooling brain to reduce metabolic demand and increase survival during systemic hypoxia.
- Case reports of unexpected (neurologically intact) survival after prolonged submersion.
- Should we rethink rescue vs. recovery if submersion occurs in cold water?
Is Cold Water Protective?

- Tipton & colleagues reviewed 43 cases of intact survival after prolonged submersion.
  - 67% were children < 12 yo
  - Longest survived submersion was 66 minutes: 2.5 yo child in 5° C water

Resuscitation 82 (2011) 819–824

Consensus-based decision-making guide for immersion incidents (from Tipton):

- Water warmer than 6° C ?
  - Yes
    - Survival very unlikely after 30 minutes submersion
  - No
    - Survival very unlikely after 90 minutes submersion

Is Cold Water Protective?

- Quan & colleagues in Seattle conducted case-control study of 1094 open water drownings in Pacific NW.
  - Compared 276 cases ("good" outcome) to 818 controls (neurologically devastated or dead)
  - Analyzed effect of duration of submersion and water temperature.

Resuscitation 85 (2014) 790–794
Univariate Association with Outcome

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<tr>
<th>WATER TEMPERATURE</th>
<th>Good Outcome</th>
<th>Bad Outcome</th>
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<tr>
<td>&lt; 6°C</td>
<td>31.9</td>
<td>34.9</td>
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<td>6° – 16°C</td>
<td>40.6</td>
<td>44.7</td>
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<td>&gt; 16°C</td>
<td>27.4</td>
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<table>
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<tr>
<th>DURATION OF SUBMERSION</th>
<th>Good Outcome</th>
<th>Bad Outcome</th>
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<tbody>
<tr>
<td>&lt; 6 min</td>
<td>88.2</td>
<td>4.7</td>
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<tr>
<td>6 – 10 min</td>
<td>7.4</td>
<td>5.0</td>
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<tr>
<td>&gt; 10 min</td>
<td>4.4</td>
<td>90.3</td>
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Is Cold Water Protective?

- In multivariate analyses
  - Duration of submersion **6-10 minutes** associated with **61% increased risk** of poor outcome.
  - Submersion **>10 minutes** associated with **98% increased risk** of poor outcome.
- No association between good outcome and water temperature

Is Cold Water Protective

- “Recommendations for initiation of rescue and resuscitation efforts should be revised to reflect the very low likelihood of good outcome following submersion greater than 10 minutes.”
Prevention Priorities for the Pacific NW

- Isolation fencing for in-ground pools
- Use PFD in and around water
- Advocate for more life-guarded locations and hours
- Teach children swimming and water safety skills
- Avoid drinking alcohol or using other substances when swimming, boating, or doing other water-oriented sports
- Provide close and constant attention to children when in or near water