INTRODUCTION

Who is at risk?
What factors influence drowning risk?
What has research found?
What makes a drowning resuscitation just like any other pediatric resuscitation?
What makes a drowning resuscitation different from any other pediatric resuscitation?
What questions linger in the science of pediatric drowning that would help us in the future?
Conclusion/Questions
OBJECTIVES

Participants will learn and be able to apply their knowledge of the following to help improve the chance of survival from drowning emergencies and reduce the risk of drowning in their communities:

- Definition of drowning and related terminology
- Identify persons at risk
- Describe the physiologic response of the body to drowning
- Conduct a scene safety evaluation upon arrival at scene
- Rapid access, assessment and treatment of the victim
- Consider opportunities for improving outcomes, including opportunities for further research and other actions that could improve chance of survival
- Engage in a conversation on unknowns about drowning

WHAT IS DROWNING?

- To die by being underwater too long and unable to breathe
- To hold (a person or animal) underwater until death occurs
- To cover (something) completely with a liquid
- To suffocate by submersion, especially in water

Merriam-Webster Dictionary
WHAT IS DROWNING?

Drowning is the process of experiencing respiratory impairment from submersion/immersion in liquid

WHO 2002

WHAT IS DROWNING?

It is NOT:
• Near drowning
• Dry or wet drowning
• Secondary drowning
• Active or passive drowning
• Delayed onset of respiratory distress
WHAT IS DROWNING?

FURTHERMORE:
The terms near, wet, dry, active, passive, silent, and secondary drowning should no longer be used.

WHY IS DROWNING IMPORTANT?

- Drowning is leading cause of death among children aged 1-4 who died from unintentional injury
- Drowning is 2\textsuperscript{nd} leading cause of death for children aged 1-4 (congenital anomalies is 1\textsuperscript{st})
- Drowning is 2\textsuperscript{nd} leading cause of unintentional injury-related death for children aged 1-14 (motor vehicle crashes is 1\textsuperscript{st})
- Depending on age, African-American children aged 5-19 are 5.5x to 10x more likely to drown in swimming pools than whites
- Nearly 80% of drowning victims are male

http://www.cdc.gov/injury/wisqars
WHY IS DROWNING IMPORTANT?

- Children aged 1-4 are more likely to drown in home swimming pools
- Children over 15 and adults are more likely to drown in natural water settings (lakes, rivers, etc.)
- Most (72%) boating accident deaths are caused by drowning, with 88% of victims not wearing life jackets
- Alcohol use is involved in about 70% of deaths associated with water recreation
- Drowning is the most common cause of unintentional injury death for persons with seizure disorders, with bathtub being site of highest risk


WHAT FACTORS INFLUENCE DROWNING RISK?

- Age
- Gender
- Race
- Ability to swim
- Body of water type
- Watercraft
- Life jackets
- Seizure history
- Other factors
PATHOPHYSIOLOGY OF DROWNING

What does drowning look like?
• Often silent or quiet—respiratory system designed to breath first, speak second
• When sinking, a victim can’t keep their head above water long enough to exhale, inhale, and call for help
• Not flailing for help; their arms are lateral or down, to push themselves up
• Often fail to kick, wave for help, or move toward a rescuer due to Instinctive Drowning Response
• They may struggle for 20-60 seconds before going under the surface


RESUSCITATION PRIORITY

• “…The initial management of a nearly drowned victim must be focused on reversal of hypoxemia and acidosis. Prompt and effective on-site CPR is of paramount importance in ensuring optimal survival.”
  AP Sarnaik, & MP Vohra

• “…The single most important step in the treatment of submersion accident victims is the immediate institution of resuscitative measures at the earliest possible opportunity.”  JP Orlowski
**RESUSCITATION**

The Basics:
- Scene safety
- Check for responsiveness
- Call for help
- Check for breathing
- ABC over CAB
- Chest compressions and breathing
- Defibrillation
- Advanced care

**SCENE SAFETY**

Obstacles to safe victim access
- Cold
- Current (water movement)
- Current (electricity)
- Creature
- Can’t Swim

*Often, there is a correlation between the obstacle in rescuing the victim and how the victim became one*
### SCENE SAFETY

**Cold Water Immersion**
- **Stage 1:** Cold-Shock (0-2 minutes)
- **Stage 2:** Functional Disability (2-30 minutes)
- **Stage 3:** Hypothermia (>30 minutes)
- **Stage 4:** Post-Rescue Collapse (>30 minutes)

**Treatment:**
- Monitor the ABCs
- Handle gently
- Rewarm gently
- Transport to definitive care

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*OnScene The Journal of the US Coast Guard Search & Rescue Fall 2006*
SCENE SAFETY

Current (Water Movement) Hazards
• Strainers
• Low head dams
SCENE SAFETY

SCENE SAFETY
**Current (Electricity)**

- Electric Shock Drowning
Electric Shock Drowning

- ESD is the result of the passage of typically a low level of AC current through the body with sufficient force to cause skeletal muscular paralysis, rendering the victim unable to help him/herself while immersed in fresh water, eventually resulting in drowning.
- Commonly occurs around docks with electricity for docked boats or other purposes; originates from shore based electrical supply
- Higher levels of electricity can result in electrocution
- [http://www.electricshockdrowning.org/esd--faq.html](http://www.electricshockdrowning.org/esd--faq.html)
SCENE SAFETY


Creatures:
• Alligators
• Snakes
• Jellyfish
• Other creatures
Can’t Swim:
• Joe Delaney

RESUSCITATION

Remove the victim from the water
• Victim is buoyant in the water; less so when removed
• Get help if possible; move victim to shallow water
• Absence of breathing has priority over possible spinal cord risk
• Check for responsiveness
• Initiate breaths in the water; compressions when on dry ground or firm surface
• Time is the enemy!
RESUSCITATION

Considerations:
• Consider breaths while the victim is still in the water if patient is apneic
• Some drowning victims still have a pulse when apneic
• Remove victim from water to start compressions
• Get help if you can!
• Rescue from land if possible

CALL FOR HELP

• If alone, initiate breaths first
• Landline versus cell phones

Information the dispatcher needs:
• What is your location/address?
• Is the patient responsive?
• Is the patient breathing?
• Is the patient out of the water?
• What is your phone number?
• Are there any obstacles to gaining access (locked gates, doors, etc.) to your location?
AIRWAY MANAGEMENT & PHYSIOLOGY

• Victim may initially swallow or spit out water
• Victim may hold breath as long as possible
• Eventually, water is aspirated
• Laryngospasm may occur
• Hypoxemia and brain hypoxia cause unconsciousness
• Cardiac rhythm progresses to tachycardia followed by bradycardia, PEA, and asystole
• Immersion to cardiac arrest occurs from seconds to minutes
• If patient is hypothermic or drowning in ice water, process can last for an hour

Szpilman D, et al. NEJM 2012

AIRWAY MANAGEMENT & PHYSIOLOGY

Water in the lungs?
• If patient is rescued alive, the clinical outcome determined by quantity in the lungs (less is good)
• Freshwater in alveoli erodes surfactant
• Saltwater in alveoli erodes surfactant
• All studies identify brain anoxia as the main problem
• In some cases, laryngospasm provides temporary protection to the lungs (Szpilman, NEJM, 2012)
• Drowning occurs without aspiration of water in 7-10% of all victims; autopsies show varying amounts of water in victim’s lungs (Modell, NEJM, 1993)
Should responders clear the airway?

The most frequent complication during a resuscitation attempt is the regurgitation of stomach contents, which occurs in more than 65% of persons who require rescue breathing, and 86% of those who require CPR.

Comparison of head-down position versus head-trunk position for drowning victims on sloping beaches

- Approach first considered in the 1800s
- Never considered risk of vomiting
- Szpilman, et al studied 84 case in Brazil 1993-2000
- Regurgitation present in 87% of head-down patients, but only 16% of head-trunk
- Mortality was 95% head-down, 80% head-trunk (73/84 died overall)
- Recommendation to avoid head-down position versus head-trunk position and avoid abdominal thrusts
AIRWAY MANAGEMENT & PHYSIOLOGY

Abdominal thrusts?

- Balance of opening airway and initiating resuscitation versus the physical act of lifting the victim to an upright position also suggests that this is not a good option
- Could there be a benefit to some drowning victims by performing a quick head tilt or log roll to the side before initiating resuscitative measures?
- Must balance the potential value against the overwhelming evidence that victim needs prompt and aggressive resuscitation to survive

CIRCULATION

Check pulse

- Some victims only need breaths initially
- When needed, 30:2 compressions/breaths
CIRCULATION

Using extracorporeal circulation
• German study between 1987 and 2007
• N=13
• Average age was 3.2 years
• Core temperature range at admission was 20-29C
• Circulation restored in 11 patients
• Patients survived to discharge=5
• Two patients died later of pulmonary complications
• One lost to follow-up
• Two patients survived with neuro complications


CIRCULATION

Resuscitation Outcomes
• Study evaluated outcomes in drowned children with cardiac arrest and hypothermia
• N=160 (1993-2012)
• N=98 had resuscitative efforts >30 min
• All died or had severe neuro disability
• N=62 did not require prolonged resuscitation
• Varying degrees of neurologic outcomes
• N=44 survived past one year
Conclusion: Very poor outcome or death if resuscitation takes longer than 30 minutes
Kieboom JK, et al.

### POST-INCIDENT

**Collect Data**
- Utstein Reporting Format
- Data collected on clinical events, time intervals and points, pathophysiological changes, autopsy findings, and other observations common to cardiac arrest and CPR research
- Good data collection helps identify opportunities for improved techniques and opportunities to improve survival

### PREVENTION

- Learn swimming skills and water-safety survival skills
- Always swim with others
- Obey all safety signs and warning flags
- Never go into water after consuming alcohol
- Avoid inflatable swimming aids; know how and when to use a life jacket
- Swim in areas with lifeguards
- Know weather and conditions before going in water
- Always enter unfamiliar or shallow water feet first
- Do not overestimate swimming ability
- Know how to stay safe from rip currents at the beach
PREVENTION

• Help and encourage others, especially children, to learn swimming and water-safety survival skills
• Always provide close attention to children you are supervising in or near the water
• Know how and when to use a life jacket, especially for children and weak swimmers
• Learn first aid and CPR
• Learn safe ways or rescuing others without putting yourself in danger
• Fence in a pool on four sides and install a self-closing, self-latching gate
PREVENTION

QUESTIONS????

SUMMARY