Cold Water Shock, Hypothermia and Cardiac Arrest
In spring the warm air temperatures lure hibernating humans out of the house.... and the waters beckon....
While the air temperature may be 60-80°F, the water is often a frigid 40-60°F.
4 Phases of Cold Water Immersion

- Cold Shock Response
- Cold Incapacitation
- Hypothermia
- Circum-rescue Collapse
What is cold water shock?

It is the body’s involuntary *physiologic* response to immersion in cold water.

- Loss of breathing control
- Initial series of *INVoluntary* gasps
  (If one’s head is submerged when this occurs, will result in immediate death by drowning)
- This is *immediately* followed by hyperventilation, tachycardia and peripheral vasoconstriction.

*Deaths that have occurred were 67% in healthy people who were strong swimmers, within 3 meters of shore (55%). Most were found with no inhaled water*

Cold shock reaches maximum intensity at water temps between 50-60°F, meaning one cannot have increased loss of breathing control in colder water.
• **Hyperventilation Results in Hypocapnia which causes:**
  - Decreased blood flow to brain
  - Dizziness
  - Confusion
  - Loss of consciousness
  - Ability to hold one’s breath is reduced 25-30%
  - Feeling of claustrophobia and not being able to inhale *enough* air
  - Panic and disorganized behavior in the water (and psychological panic component can feed ongoing hyperventilation)
  - Massive increases in heart rate and blood pressure

*Theorized to be caused due to simultaneous stimulation of Sympathetic (tachycardia) and Parasympathetic (bradycardia) nervous system. This autonomic conflict can predispose healthy people to lethal arrhythmias.*
Mark J. Tamkus, 62, of 42607 Camp Tousey Rd., in Redwood, NY, was found under his capsized kayak at 3:00 p.m. by the Jefferson County Special Tactics and Rescue team after his family had reported him missing earlier in the day. The kayak was found floating upside down in a small area of open water in front of his lakeside home. Millsite Lake was still mostly ice-covered, and the water temperature at the time of capsize was 32F. Mr. Tamkus, who was not wearing a sprayskirt, drowned before he was even able to exit the kayak. Following an autopsy conducted that evening at Samaritan Medical Center in nearby Watertown, Jefferson County medical examiner Dr. Samuel A. Livingstone, ruled that he died of asphyxia due to cold-water drowning.
• The Respiratory phase of Cold shock lasts 3-4 minutes.
• Most deaths occur in the 1st minute.
• Individuals with heart issues are even more susceptible to sudden death from arrhythmia or MI.
• Cold shock is directly related to amount of skin exposed to cold water. Proper clothing (Dry suits with rubber gaskets can prevent this).
• Hypothermia may take up to 30 minutes to occur... Most deaths occur before hypothermia develops.
Cold Incapacitation

Cold incapacitation (swim incapacitation) occurs when muscles and nerves cannot function due to reduced blood flow and effects of cooling. Average time to Cold incapacitation is **10 minutes**, occurring in many people sooner. If no floatation to keep head above water, drowning will occur. Victim unable to assist in rescue.
Hypothermia

- Can take up to 30 minutes (women and children can occur sooner due to less body mass.)
- Delayed due to bodies defenses (peripheral vasoconstriction & shivering)
- Most deaths occur before Hypothermia develops
Circum-Rescue Collapse

• Can happen just before, during or after rescue
• Sudden mental and physical relaxation following extremely high stress response
  • Sudden decrease in stress hormone response
    • Can cause profound hypotension, cardiac arrest, shock like state, weakness and muscle failure, fainting
• Victim will no longer be able to effectively assist in their own rescue
• Also during re-warming victims can have sudden hypotension due to vasodilation which can cause hypotension and circulatory collapse.

• This can occur up to 24 hours after rescue
Prehospital Care

Cold water immersion victims are at high risk for dysrhythmias. Theorized to be caused due to simultaneous stimulation of Sympathetic (tachycardia) (cold water shock response) and Parasympathetic (bradycardia) nervous system (dive response breath holding). This autonomic conflict can cause cardiac dysrhythmia. Increased risk in victims with CAD, channelopathies, long QT syndrome (genetic or medication induced).

- Can begin to be prone to cardiac arrest at core temps of 93°F or earlier due to cold shock induced dysrhythmia or MI
- Prevention in field is best achieved by prevention of further heat loss and active external re-warming of the victim (Vapor barrier and Insulation)
- Gentle handling and horizontal extrication from water
• Cardiac pacing and atropine are generally ineffective

• Lidocaine is ineffective in preventing hypothermia induced arrhythmias

• Hypothermic patients are more difficult to resuscitate, but may fully recover after prolonged CPR and multiple defibrillation attempts.
Air Temp low 60's
Water Temp in 60's
No Dry top
Only paddle jacket (wet)
CPR 23 minutes
6 defibrillations
Amiodarone and Epinephrine
NO NEURO DEFICITS!

Back from the dead after 23 minutes
By Rick Rasles, Performance Coach

Teamwork makes the dream work.

This is an expression I've used for years as a performance coach, but never have I been so grateful to have teamwork demonstrated in the manner it was on the day I died.

The paddlers at Wausau Whitewater Park in Wisconsin are like family! In the five years I've been paddling, WWPP has definitely become one of my favorite places to paddle.

There is an incredibly strong sense of community among the paddlers. Everyone looks out for each other, helps when they can, and provides encouragement in a sport that can certainly be intimidating on your own.

The flow of the water at WWPP is also dam release, so the freestyle features are predictable, which is a bonus. If you are unfamiliar with freestyle kayaking (also referred to as playboating), it involves getting on wave features on the river to attempt to surf them, or do more advanced tricks like cartwheels, loops, space gozillas, or phonics monkeys, etc.

In my business as a performance coach working with athletes, I challenge them to "take it to the next level." When I turned 50, I had played volleyball for 32 years. For 20 of those years, I traveled around the country as the "One Man Volleyball Team" using volleyball as a platform to share a drug-free, motivational message in school assemblies/camps.

I felt I needed to challenge myself to pick up a new sport and go through the learning process from ground zero. When I first was exposed to freestyle kayaking, I knew I had found my new sport. Picking up such an aggressive sport might be out of the norm for someone my age, but I never claimed to be normal!

My encounter with death happened on August 29, 2015, but the perfect storm may have started weeks before that day.

I was coming off of three solid weeks of three to four teamwork motivation sessions a day, each lasting several hours. It can easily be a 16-hour day with the unloading of equipment, packing up between sessions, and driving. After squeezing in my workouts, I usually operate on less than five hours of sleep a night. Unfortunately, my diet also suffers when I'm eating on the run. No one loves their work more than I do, and I'm always excited about making an impact with the student athletes, but I tend to run on adrenaline at times.

That fateful morning, I woke up at 4:30 a.m. and drove four hours to WWPP in Wausua, Wisconsin.

When I arrived at WWPP and prepped for paddling that morning, I was running on empty, but I was pumped about taking my paddling skills to the next level. It didn't take me long to realize that I hadn't packed my dry-top. Before leaving...
Emergency Department Care

- Gentle intubation (for Respiratory failure) and IV access
  - Remove wet clothing and replace with dry
    - Measure core temp
  - Mild to moderate hypothermia can be rewarmed with surface warming techniques
  - Severe hypothermia is a true emergency warrants rapid rewarmed efforts.
    - Maximize oxygenation
  - Restore cardiac perfusion (Defibrillation is futile in core temp < 86°F, continue CPR and rewarmed efforts and attempt Defibrillation when core temp above 86°F)
  - US Wilderness Emergency Medical Services Institute recommends empiric Bretylium (if available). Is the only medicine with evidence of preventing dysrhythmia in hypothermic patients (Based on 4 animal studies and 2 human case reports, human studies unethical).
  - Use of warmed saline, heat lamps, warm blankets, other external warming devices (bear hugger), Warm humidified oxygen, etc. other methods depending on institutional availability, provider experience.
  - Maintain efforts if patient in cardiac arrest until after patient is normothermic as full recovery may still be possible. If V-Fib persists in spite of re-warming, use of AHA ACLS protocol is recommended. If resuscitation remains unsuccessful after patient is rewarmed, then consider terminating efforts. No attempt should be made on victims with a frozen chest or other non-survivable injury.
Further Considerations

- Frostbite treatment
- Possible pulmonary edema due to thermal lung injury or near drowning.
- Treatment for pneumonia or other infections (gangrene).
- Monitor for signs of rhabdomyolysis
http://beyondcoldwaterbootcamp.com/4-phases-of-cold-water-immersion
http://www.expeditionmedicine.co.uk/index.php/advice/resource/r-0024.html
http://padlemehard.com/?p=2019
http://www.coldwatersafety.org/WhatIsCold.html
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3459038/

*Sea Kayaker, “Cold and Alone on an Icy River.”* Morgan, Randy; August, 2010