The Worst Way to Die?

The Near-Drowning Experience

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If you could choose how you were going to die, what method would you pick? Most people say they would like to "pass away in their sleep" or "go to bed and never wake up," and why not? It is quick, easy, and, most importantly, painless.

On the other hand, what would you consider the worst way to die? A majority almost unanimously mention two truly horrible deaths: fire and drowning.

To better understand the near-drowning experience, close your eyes and imagine the following common childhood experience: You are seven years old at summer camp, and you challenge your friend to try to swim all the way from the raft to shore underwater. You dive in, swim for what seems to be an eternity, and, if your lungs and endurance are up to the challenge, you make it to the other end—tired, but triumphant.

But suppose, as you try to rise above the surface, your legs become tangled in the weeds, and you can't come up from under the water. The challenge then dramatically changes from whether you can swim all the way to shore to how long you can hold your breath: 30 seconds? 45? Maybe even a minute? But is that long enough? Panic quickly ensues as you realize that unless help is quickly rendered, you are going to drown. All of your thoughts and actions are focused on one objective: getting above the surface of the water.

You hold your breath because there is no life-saving air available—only water. You struggle and continue to hold your breath. As time passes excruciatingly slowly, your body responds to the breath-holding and asphyxia by retaining carbon dioxide (hypercarbia) until the point is reached when breathing is involuntarily evoked. Gasping respirations ensue, and water is aspirated past the epiglottis and vocal cords into the lower airways. To protect the lungs from further water aspiration, the upper airway structures spasm and constrict so no further water enters the airway. Due to the "clamping down" of the upper airway structures, water from involuntary respirations is now ingested via the only other open passage, quickly filling the esophagus and stomach. Vomiting ensues and finally, the combination of hypercarbia and hypoxia results in much-welcomed unconsciousness. The airway muscles then relax in response to the now present terminal hypoxia, flooding the lungs with water and vomited stomach contents. Only after all of these horrific and devastating events does death by drowning occur.[1]

Definitions & Overview

Drowning is defined as "death from asphyxia while submerged, or within 24 hours of submersion," with near-drowning being a submersion "episode of sufficient severity to warrant medical attention for the victim that may eventually lead to morbidity and mortality."[1]

Drowning currently ranks as the fifth leading cause of accidental death in persons under 65 years old, and is the most frequent cause of death in the United States in children less than five years old. Tragically, the highest numbers of drownings occur in those from birth to four years of age.[1,2] One

must always remember that in addition to the needless deaths, submersion accidents leave countless more children and adults with varying degrees of neurologic impairment.

Precipitating Factors

Although drowning may manifest itself as the horrific experience described earlier, victims are more commonly described as quietly disappearing below the surface of the water and never coming back up.[2] Looking further into this leads to the conclusion that drowning must have occurred secondary to another event.

Commonly encountered precipitating factors may include head or neck injuries from diving, cardiac events, and strokes or seizures.[3] Alcohol and/or drug use, even in pediatric patients, with concurrent hypothermia, may intensify the effects of already incapacitating cold water.

Pathophysiology

Why are some victims spared from drowning? How does someone who is rescued after being submerged in cold water for 40 minutes not only survive, but have a good neurologic outcome? Statistics regarding out-of-hospital cardiac arrest victims are simply summarized: Seemingly, no one ever lives, and certainly not after being in arrest for 40 minutes before resuscitation measures are begun. How and why, then, do some victims survive submersion incidents? The answers lie in three currently held theories: the diving response, hypothermia and the combination theory.

In response to sudden asphyxia, especially in young children, the body desperately attempts to conserve its precious oxygen stores for the tissues that are most sensitive to the devastating effects of hypoxia. This is accomplished by the body's transformation into a hibernation-like state via profound bradycardia, decreased cardiac output and intense peripheral vasoconstriction. This allows for the remaining oxygen to be circulated preferentially to the truly needy organs—the heart, lungs and brain. However, only 15% of persons studied displayed this response when asphyxia was induced, thus leading to the hypothermia theory.[4]

Peripheral and core hypothermia can certainly be beneficial to the near-drowning victim; however, to minimize neurologic damage and sequelae, cerebral hypothermia must be quickly induced. To protect brain tissues from irreversible hypoxia-induced cell death by hypothermia alone, the cerebral temperature must fall by at least 7° Celsius from normal body temperature within the first 10 minutes after submersion. How this occurs is still a matter of debate. If a person is plunged into a tank of ice-cold water, the maximum cerebral cooling that occurs within the crucial first 10 minutes is only 2.5° Celsius![5] Since even immersion in ice water does not result in rapid enough cerebral hypothermia, some have speculated that additional cooling occurs via ingestion or aspiration of large quantities of water.[6] However, this theory has not been supported by current research findings.[3,4,5–7]

The global hypothermia that results, especially in cold water, can potentially assist in the outcome due to the decreased demands resulting in a lesser amount of acidosis. Currently, however, the "we really don't know, but we think it must be a combination of the diving response and hypothermia" theory continues to prevail.[3]

A Fate Worse Than Death?

If someone survives a submersion episode, prehospital, emergency and critical care providers must step back and look at the neurologic status of those we "save." As can be imagined, family mem-

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bers of near-drowning victims have two questions: "Will Johnny live?" and "If he does, will he still be Johnny?" Various predictors are currently being studied in order to better gauge resuscitation efforts and provide much-needed support and realistic hope to drowning victims' family members. Most research on near-drowning neurologic sequelae has been performed on patients in an emergency department or intensive-care unit setting.[8–13] In 1992, however, Quan and Kinder specifically addressed and evaluated the significance of prehospital assessment findings.[14]

In their study, children who survived a warm water near-drowning episode were evaluated to determine if predictors could be found for "good outcomes" (near to or at pre-submersion level of functioning) or "negative outcomes" (spastic quadriplegia, no self-help skills, persistent vegetative state or brain/physical death). Negative outcomes were associated with greater than 10-minute submersions and patients requiring more than 25 minutes of resuscitation. Full recoveries were found with less than 5 minutes of submersion, a palpable pulse with sinus rhythm, or reactive pupils. Amazingly, all patients who were found by prehospital teams not to be in full arrest were later discharged from the hospital without neurologic damage. In most of the studies however, some children continued to defy all odds by surviving prolonged immersions and cardiac arrest, and were discharged to return home as alert, playful, "Johnny."

Detailed recording of prehospital assessment findings in these patients is crucial to aid in future research efforts. Currently, in the prehospital setting, aggressive resuscitation measures should be undertaken with essentially all near-drowning victims, regardless of neurologic or arrest status. In the pediatric ICU setting, the decision later becomes not when to start treatment, but when to stop.[2,13–14]

Prehospital Assessment/Care

Prehospital care of the near-drowning patient must be safety focused and time-sensitive. Recognizing and remembering that rescuers are part of the solution, and responding in a safe and efficient manner, will allow for expedient and safe removal of the patient. Personal protection and safety are paramount during the rescue and treatment of the near-drowning patient. Removal from the water should be performed by trained rescuers, utilizing personal flotation devices and lifelines when possible.[15] By adhering to set safety standards, removal of the victim can be accomplished quickly and without further harm to the patient or rescuers.

Considering that the most devastating aspect of the drowning episode is hypoxemia, artificial ventilations should begin with patient contact while still in the water, if necessary.[15,16] If there is any possibility that the patient has sustained a cervical spine injury, remove him from the water, positioning the head and neck during rescue breathing with the spine neutrally aligned. In these cases, jaw thrust or chin-lift without head-tilt maneuvers are indicated to open the airway.[15,16] The Heimlich maneuver, which is controversial in the near-drowning arena, is not routinely recommended unless an airway obstruction, as evidenced by an inability to ventilate, is suspected.[16]

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External chest compressions should not be initiated until the patient is removed from the water. All cold water (less than 70°F) near-drowning patients should receive CPR regardless of submersion time. Resuscitation in warm water near-drowning patients is contraindicated if there is evidence of putrefaction. Controversy persists regarding resuscitating patients with extremely prolonged immersion times.[16]

Once the victim is removed from the water, initiate basic and advanced life support measures. Assess the airway for patency and remove any debris. Tracheal intubation achieves the most definitive airway control in the apneic patient.[15,16] Early, aggressive advanced life support prehospital care, including necessary field intubation, improves outcome.[15] Administer 100% supplemental oxygen via non-rebreather mask or artificial ventilation to all patients involved in submersion events. Once the airway is secured, rescue breathing should continue as needed, taking care to avoid over-ventilating the patient. Bag-valve-mask ventilation, coupled with any ingested water or debris, may lead to vomiting and increase the risk of aspiration. CPR, if appropriate, should be initiated as soon as possible. The patient's prognosis is directly related to the timeliness and effectiveness of CPR and associated ALS and BLS interventions.

Victims of submersion accidents, especially children with their proportionately higher body surface area, are often at risk for immersion hypothermia, as heat loss in water may be up to 32 times greater than in air.[17] Remove wet clothing as quickly as possible and dry off the patient. Active external rewarming is indicated in mild to moderate hypothermia and is accomplished by applying warm blankets, increasing the temperature in the rescue vehicle's patient compartment, and applying heat packs to the patient's neck, groin and axilla areas.[17,18] Active internal rewarming has traditionally been reserved for emergency room management of the severely hypothermic patient. Examples of this type of rewarming include: warm humidified oxygen, IV infusions of warmed normal saline (0.9NS) solution, peritoneal and/or pleural lavage with warmed solutions, warmed bowel and bladder irrigation, and, if available, cardiopulmonary bypass. Obtain intravenous access with normal saline at a keep-open rate. Hypotensive patients may be treated with 20cc/kg 0.9NS boluses or dopamine infusion if unresponsive to initial fluid resuscitation. Continuous ECG monitoring will assist with early detection and management of arrhythmias. Special care must be taken when handling a hypothermic near-drowning patient, as the myocardium is prone to ventricular fibrillation.[17] Arrest situations in mild to moderate hypothermic patients can be managed with standard ACLS protocols, with the only exception being longer than standard medication intervals.[17] This is quite different from severely hypothermic (comatose or arresting) patients, in which standard treatments, such as cardiac medications, are commonly limited to one round of drugs until rewarming has occurred.

Initial defibrillation attempts of 200j, 300j and 360j are recommended. Further defibrillation, like medication, is contraindicated until the body temperature has reached 86° F.[17,18] These patients should be rapidly transported to the nearest hospital for active internal rewarming procedures as previously discussed. Considering the old adage, "They aren't dead until they're warm and dead," lengthy emergency room codes while rewarming these patients are not uncommon. In general, hypothermic patients cannot be presumed dead until a core body temperature of 89.6° F has been achieved and all resuscitation efforts have been exhausted.[17,18]

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Conclusion

As previously mentioned, drowning is the most frequent cause of death in U.S. children younger than five years, with the highest number of drownings occurring in those from birth to four years of age.[2-4] By placing this in perspective, one must assume that a majority of the prehospital immersion incidents will involve children. As a result, we are also aware that any time we treat a child, we must also treat the parents. In these situations, it is imperative that prehospital personnel maintain a non-

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accusatory attitude and realize that this is a living nightmare for the child's parents. As all of our efforts focus on the patient, we must also ensure that support is available for the parents. This can be accomplished by family, friends, clergy or hospital social services, as well as simple, frequent and honest updates on the child's status.

Finally, incidents involving children pose a great emotional drain on prehospital responders, as well. Critical incident stress debriefing should be available as needed to address the emotional and psychological needs of all involved.

Near-drowning, like most trauma, is largely preventable. Fences, pool alarms, swimming lessons, CPR training and, most of all, close parental supervision, will all help in preventing these needless tragedies of children suffering through the worst way to die.

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affect comparability of study results, therapeutic strategies, prognosis and outcome. Patients in whom the presumed cause was confirmed as being correct had significantly better survival and neurological outcome.

Comment: *Cardiac arrest is usually treated as a primary heart problem. This study reinforces the ACLS treatment guidelines, which recommend consideration of the cause of cardiac arrest in those patients who present in asystole or pulseless electrical activity (PEA). If the true cause of the cardiac arrest was identified during treatment, outcomes were better. In about half of the cases when the ED diagnosis was wrong, the presenting rhythm was asystole, and the most common causes were pulmonary embolism status asthmatics, stroke, brain hemorrhage, drug overdose, sepsis and exsanguination. EMS personnel should always be thinking about the possble non-cardiac causes of a cardiac arrest. Bystander or family history, asthma medications and drug paraphernalia are examples of clues that might help in the diagnosis. If there is suspicion of a non-cardiac cause, EMS personnel should communicate this to the base hospital and consider rapid transportation. QI programs based on EMS information systems that include hospital results and autopsy reports can provide important patient outcome feedback to EMS personnel.* ■

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