

## EMS Timely Tips: Pediatric Drowning

---

Every summer children and families are drawn to oceans, pools, ponds, lakes, rivers, or streams for entertainment and exercise. As prehospital providers know all too well, fun events and gatherings near bodies of water can turn into an emergency setting in an instant.

Although drowning injuries can affect anyone, according to the CDC, children ages 1-4 have the highest drowning rates, with most occurring in swimming pools. Fatal drowning is the 2nd leading cause of unintentional injury death for children ages 1-14 with the 1st leading cause being motor vehicle crashes.

The risk for moderate to severe neurological complications and long-term disabilities are concerns for survivors of non-fatal drowning incidents. Whether in the hospital or prehospital setting, management of the pediatric drowning patient should aim to identify and treat complications, as well as prevent further anoxic injury.



Featured Speaker:

**Leslie Hueschen, MD, FAAP**

Dr. Hueschen is currently a board-certified Pediatric Emergency Medicine Physician with concurrent board certification in General Pediatrics. She has worked at Children's Mercy in the pediatric emergency department for almost nine years after completing her pediatric residency with the University of Washington and a pediatric emergency medicine fellowship at the University of Utah. In the emergency department she was the ED trauma director for five years with focus on improving the care of our injured and children. Nationally, she has worked with the Children's Hospital Association to develop learning modules around the care of drowning in children.

Transcription:

Melanie Cole: Welcome to Pediatrics In Practice with Children's Mercy Kansas City. I'm Melanie Cole. Joining me today is Dr. Leslie Hueschen. She's a pediatric emergency medicine physician at Children's Mercy Kansas City, and an Associate Professor at the University of Missouri Kansas City School of Medicine. And we're highlighting emergency medicine with our EMS, timely tips for today, pediatric drowning.

Dr. Hueschen, it's a pleasure to have you with us. Can you start for this podcast today by telling us how fun events and gatherings near bodies of water can turn into emergency settings in an instant. And although drowning injuries can affect anyone, can you speak about the prevalence of drowning incidents in children?

Dr. Leslie Hueschen: Yes. Hi. Thank you so much for having me today. Well, the incidence of drowning has been decreasing over the last 10 years, but it still is quite common and happens about one per hundred thousand people for unintentional drowning deaths. Unfortunately, this is a leading cause of unintentional death, especially in children who are one to four years old who have the highest drowning rates most occurring in swimming pools. Fatal drowning is the second leading cause of unintentional injury and death in children's ages one to fourteen with the first leading cause being motor vehicle crashes. Unfortunately, drowning can happen very quickly and a lot of times is silent, which makes it to be very tricky and needs to have ultimate awareness and vigilance around water to help prevent it.

Melanie Cole: Well, I certainly agree with you and we hear that it's a silent thing. And even for parents listening, it's really, really a scary thought. So can you describe the importance for pre-hospital setting providers of understanding the difference between the terminology, drowning versus submersion injury? Tell us a little bit about that.

Dr. Leslie Hueschen: Yes. Thank you. Well, back in 2003, we started to look at making our terminology more uniformed so that we could better characterize drowning, and also we could look at it and do research better, looking into it. We have basically streamlined it to very simple terms, terms that are either non-fatal drowning or fatal drowning to describe episodes where patients experience respiratory impairment from submersion or immersion in a liquid. We also sometimes add classifiers such as whether it is witnessed or unwitnessed or submersion versus immersion, where only part of the body is covered in water to help classify the type of drowning. In the past, people have used terms like wet or dry drowning or secondary drowning, but these are very confusing. And what they had been previously describing were

actually still episodes of true pathophysiology from drowning, and so we don't use these terms anymore.

Melanie Cole: That's so interesting. So while we're on that topic, the pathophysiology of drowning injuries can be quite complex as we're understanding. Can you give us a brief overview of the systemic effects of this type of injury and the risk for moderate to severe neurological complications and long-term disability concerns for survivors of those non-fatal drowning incidents?

Dr. Leslie Hueschen: Yes, the physiologic consequences of drowning can be a little difficult to understand. But if we kind of simplify it down, it's really all surrounding around that initial hypoxic-ischemic event, and also the reprofusion injuries that occur afterwards. Overall, drowning usually begins with a period of panic, loss of normal breathing pattern, breath holding, air hunger, which then leads to reflex inspiratory efforts. Children may only struggle for 20 to 30 seconds and are commonly silent when this occurs. These inspiratory efforts cause hypoxia secondary from aspiration of the liquid that they're submerged in or reflex laryngospasm when the liquid contacts that lower respiratory tract.

The results in hypoxia, hypercarbia and acidosis can decrease mitochondrial contractility, so how that heartbeats and also elevates the pulmonary artery and systemic vascular resistance and can produce cardiac arrhythmias that all lead to cardiac arrest. The fluid in the lungs also flushes out surfactant, leading to ventilation perfusion mismatch, atelectasis, increased vascular permeability that leads to pulmonary edema, which then can lead to acute respiratory distress syndrome or ARDS.

After much research, we found that the type of liquid didn't significantly impact the disease process since it's unusual for non-fatal drowning victims to aspirate more than three to four milliliters per kilo. But this hypoxic-ischemic event in the fluid in the lungs compounds so then you become more hypoxic.

This hypoxic-ischemic event also causes neuronal damage and leads to cerebral edema and increased intracranial pressure, which then can develop in the next 24 hours after injury, which can lead to devastating neurologic outcomes. Additionally, the acidosis and hyperemia can also affect the renal system causing acute tubular necrosis or kidney injury. These are all the different ways that it affects all the different parts of the body.

Melanie Cole: This is fascinating. And I'm sure that many people don't realize what you just listed, that was very comprehensive. So will you please discuss then rapid assessment and early management considerations for those pre-hospital providers and whether in the hospital or pre-hospital setting management of these pediatric drowning patients should aim to identify and treat those complications as well as prevent further anoxic injury, as you've just described?

Dr. Leslie Hueschen: Really the most important people in this chain of survival is our pre-hospital providers, anyone from the bystanders to our EMS colleagues. Initially, we want to get these patients recovered from the water with constant attention to the rescuers' own safety. We want to first treat the ventilation. Like I said, this is all stemming from that hypoxic-ischemic event. So trying to oxygenate and ventilate the patient will also help prevent that secondary injury and neuronal injury. So really prompt initiation of rescue breathing increases the victim's chance of survival.

So after they are out of the water, you want to check for breathing, give two rescue breaths if there's no spontaneous respirations and then next, assess for the pulse. This is slightly different than the compression only CPR that is taught in ATLS and BLS. So if there is a drowning victim, we basically think of this as airway first, airway breathing first, and then circulation. If they are pulseless after two rescue breaths, then we want you to begin chest compressions.

There's also a higher risk, as I mentioned, of cardiac arrhythmias in these patients with submersion injury. So we want too to get an AED with defibrillation pads and attach it to assess for a shockable rhythm.

Now of note, there is also very low incidence of cervical spine injuries in typical drowning victims. And so routine mobilization is not recommended and can sometimes impede in your airway management. During transport, your biggest concern is oxygenation and maintaining that oxygenation ventilation and then treating if they're in cardiac arrest. In transport to the emergency department, bag-mask ventilation is a good pre-hospital management with really no difference in outcomes in patients who received any airway device.

Lastly, and also very importantly, is that we have to assume that all these patients that are drowning victims are hypothermic. And so we want to remove all of the wet clothing that they have, wrap them in warm blankets and to attempt rewarming, should be attempted at least passively, until you arrive to the emergency department.

Melanie Cole: What great information you are imparting today. And once patients are transferred to the emergency department, pre-hospital providers rarely receive follow up on the next steps in care. Based on the patient's presentation, what are the general guidelines for triaging pediatric patients?

Dr. Leslie Hueschen: So the goal of that pre-hospital care, like I said, they're really some of the most important people. Trying to, on your way to us, reverse that hypoxia and restore normal oxygenation and circulation as quickly as possible to avoid further injuries is important. These patients can arrive in a variety of clinical states from asymptomatic to in full cardiac arrest. So helpful history that you can give us in the emergency department includes circumstances leading to the event, time of the immersion, length and degree of resuscitation and any preexisting medical conditions.

When patients arrive and are breathing spontaneously with normal oxygen saturations, so greater than 90% in good mental status, these patients actually are observed with oxygen in a continuous pulse oximeter monitor for at least eight hours. This is because we have studies done that say that if you haven't really developed symptoms within seven hours, then most likely you won't have significant sequelae from the drowning episode and you may be safe for home. If the patient has symptoms, and during that period of observation time has had coughed, tachypnea, hypoxia, or abnormal mental status, these patients will need to be admitted because of risk of worsening pulmonary symptoms or other sequelae. And in these patients, we really tried to use BiPAP or CPAP early in the patients that are still maintaining their airway to help them reduce the other risk of developing pulmonary edema and ARDS.

For those patients with cardiac arrest with drowning who do have return of circulation, we have special attention that's placed on cardiopulmonary stabilization, respiratory support and correction of hypothermia, coagulation, anticoagulation, or electrolyte abnormalities with close ICU monitoring.

If a patient has return of circulation, but did require intubation or airway procedure, we also leave them intubated for at least 24 hours before we even attempt extubation because there is a fair amount of risk of ARDS or worsening pulmonary edema that can happen those first 24 hours. Pediatric advanced life support algorithms or PALS algorithms are followed in those patients that arrive in persistent cardiac arrest. There, we focus on securing a definitive airway and doing active rewarming to get the patient back to 32 to 34 degrees Celsius. As some of you guys know, epinephrine sometimes isn't as effective below 30-degree Celsius, so we use active and passive rewarming efforts to help with this.

Really the prognosis for these patients has a linear correlation to the duration and extent of the hypoxia, which can also be linked to the degree of submersion or the length of time for the resuscitation.

Melanie Cole: What are the current statistics regarding outcomes of pediatric patients with drowning injuries, doctor?

Dr. Leslie Hueschen: So, like I had mentioned, thankfully, our unintentional drowning death rates have decreased in the last decade from 1.6 per a hundred thousand people to 1. But the rates remain higher for males, about twice as common as females, non-Hispanic black children compared to non-Hispanic white or Hispanic children and children with epilepsy, autism, or a history of cardiac arrhythmia.

These rates are also consistently higher in children living in rural counties compared to urban counties. And we do notice that there's a slight difference in where these deaths occur based on their ages. So those under one year are at significant risk of drowning in bathtubs. Patients one to 13 years old are at risk of swimming pool deaths. And patients 14 to 17 are at higher risk around natural bodies of water, such as lakes, rivers, streams, and oceans.

Melanie Cole: Doctor, as we get ready to wrap up, several EMS providers are also parents or caregivers of children. What's the drowning chain of survival? What are the commonly referenced drowning prevention interventions? Wrap it up with a summary for us and what you would like all listeners to know about these statistics and drowning prevention.

Dr. Leslie Hueschen: You know, I think one of the biggest things is that it's estimated that 80% of drownings remain

preventable. And so the International Life Saving federation recommends this drowning chain of survival to be used for anybody who recognizes an episode of drowning.

So the steps in the chain are to first prevent drowning. Prevention is really multi-tong approach such as staying within arms reach of children when you're in or near the water, swimming in water safe areas where there are lifeguards; making sure that your fenced pools, spas or other aquatic locations have a four-sided fence, which can reduce the incidence of drowning by 50% to 80%; to make sure that you're always wearing a life jacket when using a watercraft; and to learn how to swim and water safety survival skills.

The next in the step of the chain of prevention is recognizing distress. So this specifically is keeping an eye on people who are in the water and recognizing the early signs of distress. Persons may not waive or call for help and this can be quite quick.

The next is to provide flotation. And this is important because we need to reduce the risk of rescuers becoming distressed themselves. So providing flotation and helping others while still staying out of the water to reduce the risk of having injury to the rescuer.

The fourth is removal from the water, and this is only if it's safe to do so. Again, better if you are out of the water unless the rescue person is trained in removal from the water. Lastly is provide care as needed. So basically, like I mentioned, the first step is to rescue breaths if there's no spontaneous respirations and then to initiate CPR, consider the use of oxygen and an automated external defibrillator or AED as soon as possible and to call EMS for transport.

So again, that drowning chain in survival is really to try to prevent drowning before it happens, to recognize distress early, provide flotation, to remove the patient or child from the water, and then to provide care as needed, escalating calling 911 using an AED and using rescue breaths and CPR.

Melanie Cole: What an informative podcast. That's exactly what these EMS timely tips are all about. And thank you so much, doctor, for joining us today. And you can get more EMS timely tips on pediatric drowning and practical tips for emergency medicine specialists and first responders at [childrensmercy.org/ems](http://childrensmercy.org/ems).

This has been Pediatrics In Practice with Children's Mercy Kansas City. Please remember to subscribe, rate and review this podcast and all the other Children's Mercy podcasts. I'm Melanie Cole.

powered by:  doctor  
podcasting (<http://doctorpodcasting.com>)