ABSTRACT
Drowning is a leading cause of death in children and is highly preventable. More than 10 people die of drowning in the United States each day, most of them adults. Rates of drowning are highest in children given their developmental vulnerabilities. Drowning incidents that result in cardio-pulmonary arrest have a straightforward emergency clinical response, but the management approaches to the more common scenario of brief, nonfatal submersion is less clear. Clinicians must make clinical-care decisions based on evidence to provide safe and effective care in a timely manner and to help families avoid unnecessary anxiety. Such anxiety has been heightened by reports of unanticipated “dry drowning” appearing in the media. This article discusses this concept and provides guidance for clinicians. [Pediatr Ann. 2017;46(10):e354-e357.]

Drowning represents an important and highly preventable cause of child death. Most pediatricians give anticipatory guidance during well-child visits on water and pool safety as well as swim lessons. However, parents may raise concerns about drowning that can be challenging.

ILLUSTRATIVE CASE
An anxious mother presents with her 4-year-old son for an acute care visit. He had been playing in the shallow end of their neighborhood pool when she briefly lost sight of him. After approximately 1 to 2 minutes, she spotted him emerging from the water coughing and crying. After an initial drying off and comforting he appeared fine and eventually stopped coughing and could eat lunch. After they had left the pool later in the day, she encountered a friend whom she told what had happened earlier. Her friend relayed a story she heard on television about a child who “seemed fine” after such an incident but died the next day of something called “dry drowning.” After hearing that information, the mother proceeded directly to the doctor’s office.

WHAT IS DROWNING? WHAT IS “DRY DROWNING”?
The story described above and other reports are terrifying for any parent to hear. The scenario of a child inhaling water inadvertently and quick spontaneous recovery is quite common, but should it lead to a real fear of unpredictable sudden death hours or days later? The short answer is no. Children do not choke on water, recover, seem fine for several hours or days and, then suddenly die. This is the description of something that has been called “dry drowning,” also known as secondary or delayed drowning. The terms are not currently recognized medical terms and are best not used as they have led to avoidable hysteria and parental fear around this issue. The term originated from animal studies in the 1930s and 1940s that conveyed the absence of significant water in the lungs on postmortem examination. This led to a theory that prolonged reflex laryngospasm induced lethal hypoxia through postobstructive pulmonary edema. Those early studies have been examined and have largely been dismissed on the basis that there is no firm evidence that submersion events lead to prolonged laryngospasm and then death. A 2004 retrospective review of drowning cases found that the finding of no penetration of liquid in the lungs in the context of drowning is very rare.

The World Congress on Drowning adopted a standard definition of drowning in 2002 as “a process resulting in primary respiratory impairment from submersion/immersion in a liquid medium.” The outcome can be death, lasting impairment (morbidity), or complete recovery but all are considered drowning incidents and should be assessed as
such. The terms near drowning or near-fatal drowning have also fallen out of favor because they are inaccurate and their use has led to confusion. Standard classification of drowning incident outcomes is now simply two categories: fatal or nonfatal drowning. Drowning begins when a person’s airway goes below the surface of the water (submersion) or significant water is splashed on the face and water enters the oropharynx (immersion). When water enters the oropharynx, the person is triggered to spit it out or swallow it. If the water exposure continues, breath holding is the next continuum, which lasts for no longer than approximately 1 minute. The natural inspiratory drive prevails and the individual will inhale, aspirating water into the airway leading to coughing and possible laryngospasm, which quickly ceases with the onset of brain hypoxia. As hypoxia worsens, loss of consciousness occurs followed by apnea. The entire process from submersion to cardiac arrest occurs in several seconds to a few minutes. Rarely, in situations of hypothermia, the process can last for 1 hour.

Unfortunately, terms like “dry drowning” have been used in several frightening stories in mainstream and social media. Parents reading these reports are led to believe that there are no warning signs and that critical distress or death comes “out of nowhere.” Fortunately, children who have trouble hours after submersion event have warning signs that can be detected by an experienced provider. Having a firm knowledge of how drowning occurs is essential in clinical care of patients as well as in discussion with parents.

THE EPIDEMIOLOGY OF DROWNING

More than 10 people die in the United States from drowning each day. One in five are children and teenagers younger than age 15 years, for a total of 681 in 2015. For every child who dies another five receive emergency medical care for a nonfatal submersion injury. About one-half of those are admitted to the hospital for further care. Most recover completely, but some will have severe long-term neurologic deficits, usually associated with submersion times of more than 5 minutes, cardiopulmonary resuscitation delayed for greater than 10 minutes, and coma on emergency department presentation. Over the past 3 decades, fortunately, drowning has significantly decreased. Drowning deaths in 19-year-olds decreased from 1,886 in 1985 to 892 in 2014, representing almost a 60% reduction in the rate of fatal drowning over the 30-year period (from 2.7/100,000 in 1985 to 1.1/100,000 in 2014).

Age is a significant risk factor for drowning, with children age 1 to 4 years at the highest risk, followed by adolescents. Circumstances also differ by age group with younger children more often drowning in swimming pools and teens in lakes or rivers. Rates of drowning also vary by gender, race, and household income. Boys are more likely to drown than girls; accounting for nearly three-fourths of all fatal drownings. Black and Indian/Alaskan Native children have higher rates than other groups. More than two-thirds of all fatal drownings in children occur during the warmer weather months, reflecting recreational exposure.

Drownings can occur more rarely in the home environment, with risks greatest for infants and toddlers. Buckets, wells, ponds, bathtubs, and toilets provide a potential drowning source for this age group. These incidents reflect the fact that young children have a much higher center of gravity than teenagers and older children, making them susceptible to tipping head first into a body of water. Lack of adult supervision is a well-recognized risk factor for child drownings. However, one study found that parents were present in 62% of drowning deaths. In many cases, supervision was compromised by drugs, alcohol, sleepiness, or distraction.

Epilepsy is a well-studied risk factor for drowning. It is estimated that risk of drowning is 4 times that of children without epilepsy. Interestingly, when supervision is implemented, children with seizure disorders have no greater risk than children without seizures. Other risk factors, pertinent to teenagers, include alcohol and illicit drug use. It is estimated that risk of fatal drowning for a person with a blood alcohol level of 0.10 g/100 mL is 10 times that of a sober person.

CLINICAL CARE

Less than 6% of people rescued by lifeguards require emergency department care and most spontaneously recover onsite without intervention. Symptoms of drowning most commonly appear immediately, but infrequently can develop subtly between 4 and 6 hours after the incident. Symptoms can range from persistent to worsening cough, tachypnea, vomiting, and mental status changes. If, after a brief immersion event, children are persistently symptomatic or if the parent is worried, they should be taken to the nearest emergency department for assessment. They should receive a complete examination and have their oxygen saturation checked. If symptoms resolve, oxygenation is normal, and the child is doing well 6 to 8 hours after the incident they can be safely discharged home with adequate follow-up care. As children will often present immediately after an event,
this will require a short period of observation in the emergency department. Nonresolution of symptoms or hypoxia (oximetry less than 96% on room air) warrants further observation in an inpatient setting. Checking electrolytes or complete blood count is unnecessary as are prophylactic antibiotics. Obtaining a chest radiograph should be based on symptoms and examination findings.

**PREVENTION**

The American Academy of Pediatrics (AAP) recommends a multipronged approach to child drowning, referred to as use of “Layers of Protection.” This approach recognizes that effective prevention requires not only adequate supervision but physical barriers to the danger (eg, pool fencing), proper training of the child, and readiness to respond to an emergency (Table 1).

**OTHER MYTHS**

“My child knows how to swim, so is unlikely to drown” is a statement that probably assures many parents as to the safety of their children around a body of water. However, knowing how to swim does not “drown proof” anyone, especially children. For several years, the AAP advised against swimming lessons for children prior to age 4 years. This was, in large part, based on lack of data examining whether lessons increased or decreased risk of drowning. The most current policy statement has relaxed this stance based on current evidence that swimming lessons do not increase the risk of drowning for young children and in fact may be protective.

“I will be able to see my child struggle and flail about if he gets into trouble in the water” is another misconception about water safety and children. Drowning most often happens in children silently and quickly. It can happen in seconds and in most fatal scenarios the child has been out of sight for less than 5 minutes.

**CONCLUSION**

A clinician who is knowledgeable about drowning and the myths around the notion of “dry drowning” would confidently help the mother of the 4-year-old child described earlier in the article. You would gather further history and find that 8 hours have transpired since the incident and that the child has no current symptoms. The initial coughing resolved in the first 20 minutes. He appears well, with normal lung examination, respiratory rate, and oxygen saturation. He has had something to eat and drink since the incident with no vomiting. You reassure the mother that her son is fine, out of danger and all right to go home without further intervention. You talk over things to watch for if this happens again (ie, persistent and worsening cough, not acting right, color change) and the need to go to the emergency department if this happens. Most importantly, you emphasize the importance of touch supervision at this age.

**REFERENCES**


11. Morrongiello BA, Sandomierski M, Schwebel DC, Hagel B. Are parents just treading water? The impact of participation in swim lessons on parents’ judgments of children’s drown-

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**TABLE 1. Drowning Prevention: Layers of Protection**

- All pools should have four-sided, isolation fencing with a self-closing/latching gate
- All children should wear a United States Coast Guard-approved personal flotation device in and around natural bodies of water
- Touch supervision for all infants, toddlers, and weak swimmers (child is within an arm’s reach with constant visual contact)
- Constant focus supervision for all older children (nondistracted, close, and constant)
- No alcohol, drug, or excessive cell phone use for those who are supervising children near water
- Swimming lessons and water safety education for children and adults
- Teach children to not swim alone
- Learn cardiopulmonary resuscitation and have a phone ready to call emergency medical services

Adapted from the American Academy of Pediatrics, Committee on Injury, Violence, and Poison Prevention Policy Statement on Prevention of Drowning. 17