Childhood water submersion remains a major public health problem in many countries with significant morbidity and mortality. Near-drowning occurs when the child recovers from water submersion, whereas, drowning is defined as suffocation and death from such submersion. Man people (estimated at 500,000/ear) die from drowning worldwide, with the majority occurring in developing countries. Among all pediatric accidental deaths in the United States, drowning is the second leading cause accounting for more than 1000 deaths annually. However, the estimated annual hospitalizations associated with drowning declined from 4.7/100 000 in 1993 to 2.4/100 000 in 2008.

The rates declined for all age groups, and for both males and females. Similar data from developing countries are lacking. However, it is important to note that for ever child who drowns, at least 3 receive emergency care for near-drowning, and more children are never brought to the hospital. The frequency of near-drowning is therefore, much higher because of under-reporting. The aim of this article is to present an updated overview of the topic with data from our region and special attention to prevention strategies.

**Risk factors and predisposition.** Males are at higher risk than females. Most drowning occurs in fresh water, particularly in residential swimming pools. The use of portable pools also poses a significant risk for younger children. However, children less than 5 years of age often drown in washing containers, up to 55% of cases in one study from Saudi Arabia. Open wells are also a special risk in our region. In general, predisposing circumstances depends on the child’s age. Infants are at higher risk of drowning in bathtubs, toilets, or traditional washing.
Near-drowning and drowning ... Jan

machines, while most drowning in older children occurs in residential swimming pools. Bathtubs are particular risk even with few centimeters of water because infants ma not be able to lift themselves up once the slipped and submerged. Infant bath seats do not provide full protection and should never replace close adult supervision. Larger buckets and traditional washing machines are a hidden danger to curious young children. Children ma be able to pull themselves up into the water container, however, due to their relatively large head, the ma not be able to lift themselves out, or tip the water- lled container. Poor supervision b inexperienced caregivers is a common factor and contributes to most deaths in children less than 5 years of age. Brief period of no supervision is usually enough for such a disaster to happen. Child neglect should be suspected in such cases. Man families from our region lacked the necessary general infant and child safety practices. In one Saudi study, up to 87% of the victims were not properly supervised at the time of the event. Children from lower social economic families are exposed more frequently to buckets and laundrubs making them predisposed to drowning this way. Adolescents drown more often in outdoor water activity such as rivers, lakes, and ponds. In our region, water collections following seasonal heavy rain are a common site for such accidents. In other countries, alcohol or drug use may be involved. Inexperienced male adolescents ma engage in risk water behavior and tend to overestimate their swimming abilities. Open lakes and large rain water collection increases the risk of drowning rather than near drowning because of lack of close supervision and availability of emergencyservices. Finall, an important risk factor for drowning is active epilepsy. The risk is even higher if the patient is also mentally retarded. Because of this risk, patients with epilepsy should take showers rather than use bathtubs.

Clinical manifestations. Multiple body stems are acted in var ing severit b near-drowning and the associated h poxic ischemic injur. During the submersion, the child initiall will hold breath; tr to surface, panic, followed b water aspiration. The patient then becomes h poxic, loses consciousness, and stops breathing. Silent drowning occurs in less than 10% of cases when lar ngospasm is triggered b initial water aspiration resulting in dr rather than wet lungs. Water inhalation is usually associated with bronchospasm and atelectasis with subsequent intrapulmonary shunting of blood through poor ventilated tissues. is further reduces ventilation and ox genation. If the patient is rescued, one should watch for later development of pulmonar edema and adult respirator distress ndrome. Neurological manifestations occur in up to 10% of near-drowning patients depending on the duration and severity of the initial h poxic-ischemic insult. ese patients should be monitored for brain edema during the rst 3 da s post injur. Other manifestations and complications include cardiac d sfuction, arrh thmias, acidosis, electrol te imbalance, h potension, and h pothermia. H pothermia ma result in sign cant h povolemia as a result of peripheral vasoconstriction. Dierences in the osmolarity of fresh and salt water ma result in speci c uid and electrol te abnormalities. Fresh water is h potonic relative to plasma causing h povolemia and dilutional h ponatremia, while salt water is h pertonic causing h povolemia and h ponatremia. However, such sign cant changes in uids or electrol tes are less common in clinical practice. In fact, metabolic acidosis is more common than electrol te disturbances. Patients with more severe near-drowning ma develop shock with associated anemia, acute tubular necrosis and disseminated intravascular coagulation.

Acute management. Acute management should start as soon as possible in order to prevent unfavorable neurological outcome. Cardio-pulmonar resuscitation (CPR) should be started at the scene. Due to lack of training, families rarely tr to perform such resuscitation. Cervical spine immobilization should be performed if a high impact event is suspected, such as diving or falls. e airwa, breathing, and circulation should be assessed. However, maneuvers to remove uid from the lungs, such as chest or abdominal compressions, are no longer recommended because of lack of e cac. As well, these compressions ma dela CPR, and increase the risk of vomiting and aspiration. CPR can be performed with uid in the lungs as long as there is no airwa obstruction.

Once in the hospital, the cervical spine needs to be examined and x-ra ed for possible injuries or fracture. is is uncommon in young children and should not dela or interfere with acute management. Complete blood count, electrol tes, blood gas, and chest x-ra should be obtained promptl. Respirator support and management of bronchospasm or pulmonar edema is critical. Nebul ed beta agonist and furosemide are used for this purpose. Antibiotics and steroids should not be used routine unless the water is contaminated. In such cases, bronchoscopy and bronchial lavage ma be needed to remove aspirated particulate matter. Finall, surfactant and extracorporeal membrane ox genation can be utilized in severe cases. Treatment of other manifestations and complications, such as h potension, sei ures, and renal ds fuction is needed. Cerebral...
edema should be promptly treated in order to improve the neurological outcome. H. pothermia is common in children because of their large surface area and tends to improve quicker by rewarming.

**Outcome and neurological morbidity.** Most patients improve quickly with acute management. If the child does not improve or deteriorates, other etiologies or complications should be considered, including head injury, blood loss, alcohol, or drug ingestion. Children generally either survive with no neurological sequelae, or die following water submersion. Most children who are rescued quickly will recover neurologically intact.27 Most deaths occurred in young children (<5 years) who were unsupervised, or in older children who swam in open water. As mentioned earlier in the introductory segment, there is some recent evidence that pediatric hospitalization rates for drowning, as well as fatal drowning have decreased over the past 16 years.4 Only 5-10% develops severe neurological sequelae.28 Factors that correlated with neurological morbidity included submersion or CPR for more than 25 minutes.29 H perigl cemia (glucose ≥10 mmol/L) correlated with bad outcome in one Saudi study.30 In another study, h pothermia was the only independent predictor of poor neurological outcome.31 Few other published reports described a relatively better neurologic outcome following submersion in very cold water.32

**Prevention strategies.** Restricting access to water and close adult supervision once in the water are paramount in preventing near-drowning and drowning.33 Children must always be supervised, regardless whether the can swim well, or not. In a Saudi report, no adults were watching the children when the accidents occurred in all mortalit cases.6 Most young children drown in their own pool, or in friend’s pool because of easy access and lack of strict supervision.34 Such pools should be fenced or completed isolated from the yard in order to reduce the risk of submersion.35 It is preferred if the fence is at least 1.4 meters tall, and have a self-closing gate.36 Safety accessories and equipment are not always provided in residential swimming pools, particularly in lower socioeconomic families.

In our region, most of the private swimming pools do not meet the required safety regulations.11,30 In addition, all public or commercial pool facilities should have a telephone and a monitoring stem. Pool covers could add further security when the pool is not used or closed. The CPR training of parents and pool owners will ensure early and more effective rescue, and therefore improves the outcome of such incidents. Pediatricians should encourage parents to take CPR courses, and teach their children how to swim well.

In our community, CPR knowledge or training is virtually nonexistent.11,30 Educating the general public regarding drowning prevention is also essential. The media, as well as government authorities should play a major role in increasing public awareness to minimize such incidents. No single strategy will prevent all submersion deaths and injuries; therefore a strong and pervasive education campaign is needed to make the public aware of these dangers. High-risk groups, such as new or young parents, lower socioeconomic families, and families with prior child protective services referrals, should be targeted with drowning prevention programs. Such increased awareness and safety campaigns can be successful in reducing near-drowning and saving precious young lives.

**References**


Illustrations, Figures, Photographs

Four copies of all gures or photographs should be included with the submitted manuscript. Figures submitted electronically should be in JPEG or TIFF format with a 300 dpi minimum resolution and in gra scale or CMYK (not RGB). Printed submissions should be on high-contrast gloss paper, and must be unmounted and untrimmed, with a preferred size between 4 x 5 inches and 5 x 7 inches (10 x 13 cm and 13 x 18 cm). e gure number, name of rst author and an arrow indicating top should be t ped on a gummed label and a xed to the back of each illustration. If arrows are used these should appear in a di erent color to the background color. Titles and detailed explanations belong in the legends, which should be submitted on a separate sheet, and not on the illustrations themselves. Written informed consent for publication must accompan an photograph in which the subject can be identi ed. Written cop right permission, from the publishers, must accompan an illustration that has been previously published. Photographs will be accepted at the discretion of the Editorial Board.