Part 10.3: Drowning

Drowning is a leading preventable cause of unintentional morbidity and mortality. Although this chapter focuses on treatment, prevention is possible, and pool fencing has been shown to reduce drowning and submersion injury (Class I).[1]

The most important and detrimental consequence of submersion is hypoxia. Therefore, oxygenation, ventilation, and perfusion should be restored as rapidly as possible. This will require immediate bystander CPR plus immediate activation of the emergency medical services (EMS) system. Victims who have spontaneous circulation and breathing when they reach the hospital usually recover with a good outcome.

Victims of drowning may develop primary or secondary hypothermia. If the drowning occurs in icy (<5°C [41°F]) water, hypothermia may develop rapidly and provide some protection against hypoxia. Such effects, however, have typically been reported only after submersion of young victims in *icy* water (see Part 10.4: "Hypothermia").[2]

All victims of drowning (see definitions below) who require any form of resuscitation (including rescue breathing alone) should be transported to the hospital for evaluation and monitoring even if they appear to be alert with effective cardiorespiratory function at the scene. The hypoxic insult can produce an increase in pulmonary capillary permeability with delayed onset of pulmonary complications.

Definitions, Classifications, and Prognostic Indicators

A number of terms are used to describe drowning. To aid in the use of consistent terminology and the uniform reporting of data from drowning, the Utstein definition and style of data reporting are recommended[3]:

Drowning. Drowning is a process resulting in primary respiratory impairment from submersion/immersion in a liquid medium. Implicit in this definition is that a liquid/air interface is present at the entrance of the victim's airway, preventing the victim from breathing air. The victim may live or die after this process, but whatever the outcome, he or she has been involved in a drowning incident.

A victim may be rescued at any time during the drowning process and may not require intervention or may receive appropriate resuscitation measures. In either case the drowning process is interrupted.

The Utstein statement recommends that the term *near-drowning* no longer be used. It also de-emphasizes classification based on type of submersion fluid (salt water versus fresh water). Although there are theoretical differences that have been reported in laboratory conditions, these have not been found to be clinically significant. The most important factors that determine outcome of drowning are the duration and severity of the hypoxia.

Although survival is uncommon in victims who have undergone prolonged submersion and require prolonged resuscitation,[4,5] successful resuscitation with full neurologic recovery has occasionally occurred with prolonged submersion in icy water.[6–8] For this reason, scene resuscitation should be initiated and the victim transported to an ED unless there is obvious physical evidence of death.

Modifications to Basic Life Support for Drowning

No modification of standard BLS sequencing is necessary. Some cautions are appropriate, however, when beginning CPR for the drowning victim.

Recovery From the Water

When attempting to rescue a drowning victim, the rescuer should get to the victim as quickly as possible, preferably by some conveyance (boat, raft, surfboard, or flotation device). The rescuer must always be aware of personal safety.

Recent evidence indicates that routine stabilization of the cervical spine is not necessary unless the circumstances leading to the submersion episode indicate that trauma is likely (Class IIa). These circumstances include a history of diving, use of a water slide, signs of injury, or signs of alcohol intoxication.[9] In the absence of such indicators, spinal injury is unlikely. Manual cervical spine stabilization and spine immobilization equipment may impede adequate opening of the airway, and they complicate and may delay the delivery of rescue breaths.

Rescue Breathing

The first and most important treatment of the drowning victim is the immediate provision of ventilation. Prompt initiation of rescue breathing increases the victim's chance of survival.[10] Rescue breathing is usually performed when the unresponsive victim is in shallow water or out of the water. If it is difficult for the rescuer to pinch the victim's nose, support the head, and open the airway in the water, mouth-to-nose ventilation may be used as an alternative to mouth-to-mouth ventilation. Untrained rescuers should not try to provide care while the victim is still in deep water.

Management of the drowning victim's airway and breathing is similar to that recommended for any victim of cardiopulmonary arrest. There is no need to clear the airway of aspirated water, because only a modest amount of water is aspirated by the majority of drowning victims and it is rapidly absorbed into the central circulation, so it does not act as an obstruction in the trachea.[5,11] Some victims aspirate nothing because they develop laryngospasm or breath-holding.[5,12] Attempts to remove water from the breathing passages by any means other than suction (eg, abdominal thrusts or the Heimlich maneuver) are unnecessary and potentially danger-

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ous.[11] The routine use of abdominal thrusts or the Heimlich maneuver for drowning victims is not recommended.

Chest Compressions

As soon as the unresponsive victim is removed from the water, the rescuer should open the airway, check for breathing, and if there is no breathing, give 2 rescue breaths that make the chest rise (if this was not done in the water). After delivery of 2 effective breaths, the lay rescuer should immediately begin chest compressions and provide cycles of compressions and ventilations. The healthcare provider should check for a central pulse. The pulse may be difficult to appreciate in a drowning victim, particularly if the victim is cold. If the healthcare provider does not definitely feel a pulse within 10 seconds, the healthcare provider should start cycles of compressions and ventilations. Only trained rescuers should try to provide chest compressions in the water.

Once the victim is out of the water, if the victim is unresponsive and not breathing (and the healthcare provider does not feel a pulse) after delivery of 2 rescue breaths, rescuers should attach an AED and attempt defibrillation if a shockable rhythm is identified. If hypothermia is present, see Part 10.4.

Vomiting by the Victim During Resuscitation

The victim may vomit when the rescuer performs chest compressions or rescue breathing. In fact, in a 10-year study in Australia, two thirds of victims who received rescue breathing and 86% of victims who required compressions and ventilations vomited.[13] If vomiting occurs, turn the victim's mouth to the side and remove the vomitus using your finger, a cloth, or suction. If spinal cord injury is possible, logroll the victim so that the head, neck, and torso are turned as a unit.

Modifications to ACLS for Drowning

The drowning victim in cardiac arrest requires ACLS, including early intubation. Every drowning victim, even one who requires only minimal resuscitation before recovery, requires monitored transport and evaluation at a medical facility.

Victims in cardiac arrest may present with asystole, pulseless electrical activity, or pulseless ventricular tachycardia/ventricular fibrillation (VF). Follow the guidelines for pediatric advanced life support and ACLS for treatment of these rhythms. Case reports document the use of surfactant for fresh water–induced respiratory distress, but further research is needed.[14–16] The use of extracorporeal membrane oxygenation in young children with severe hypothermia after submersion is documented in case reports.[8,17] There is insufficient evidence to support or refute the use of barbiturates, steroids,[18] nitric oxide,[19] therapeutic hypothermia after return of spontaneous circulation,[20] or vasopressin.[21]

Improving Neurologic Outcomes: Therapeutic Hypothermia

Recent randomized controlled trials (LOE 1)[22] and (LOE 2)[23] and subsequent consensus recommendations[24,25] support the use of therapeutic hypothermia in patients who remain in a coma after resuscitation from cardiac arrest caused by VF and note that it may be effective for other causes of cardiac arrest. However, the effectiveness of induced hypothermia for drowning victims has not been established, and evaluation of this approach is warranted. The 2002 World Congress on Drowning recommended further studies to identify the best treatments for drowning victims.[3]

Summary

Prevention measures can reduce the incidence of drowning, and immediate, high-quality bystander CPR and early BLS care can improve survival. Rescue breathing should be provided even before the victim is pulled from the water if possible. Routine stabilization of the cervical spine is not needed. Further studies are necessary to improve neurologic outcome for drowning victims.

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