

# Ventilations and Airway Management



## Immediate In-Water Resuscitation

**Last Full Review: ILCOR 2023; American Red Cross Scientific Advisory Council 2019**

Most drownings among children ages 1 to 4 years old take place in a home pool, where rescue can be rapid and resuscitation can be started immediately after removal from the pool ([National Center for Injury Prevention and Control 2022](#)). In older children and adults, drowning may take place in a lake, river or ocean, creating potential delays in starting cardiopulmonary resuscitation or raising concern for the use of an automated external defibrillator when the drowning person is close to the water and with wet skin.

Is there evidence to support in-water resuscitation with ventilations only?

### Red Cross Guidelines and Best Practices

- In-water resuscitation with ventilations can be considered in cases where a responder has proper training in the in-water resuscitation technique and is comfortable performing it without causing an unsafe environment for the responder or the drowning person.
- Though in-water resuscitation can be performed without the aid of additional equipment, floating and propelling equipment should be considered.

### Evidence Summary

The topic of in-water resuscitation was most recently evaluated systematically by the American Red Cross Scientific Advisory Council in 2019 (American Red Cross Scientific Advisory Council 2019). No additional studies were identified in a 2022 update. The American Red Cross Scientific Advisory Council scientific review focused on the technical feasibility and clinical outcomes. A single retrospective observational study was identified ([Szpilman and Soares 2004, 25](#)) that included 46 adults and children found unresponsive and apneic in the open water off the beaches of Brazil. Of these, 19 received in-water resuscitation by lifeguards, compared with 27 who did not. Retrospective analysis showed significantly higher prehospital and hospital survival with in-water resuscitation. Patients with a cardiopulmonary arrest

duration for more than 14 minutes had a poor outcome. The authors concluded that delayed resuscitation efforts were associated with a worse outcome for nonbreathing drowning persons, and in-water resuscitation was associated with an improved likelihood of survival.

Other in-water, resuscitation-specific studies using manikins in simulated open-water rescue scenarios ([Abelairas-Gómez et al. 2017, 176](#); [Barcala-Furelos et al. 2016, 480](#) ; [International Life Saving Federation 2018](#); [Lungwitz et al. 2015, 379](#)) reported that:

- In-water resuscitation is feasible by mouth-to-mouth, bag-mask and laryngeal tube ventilation.
- In-water resuscitation increases the time and perceived difficulty of a rescue.
- In-water resuscitation increases the amount of measured water aspiration on the part of the drowning person.
- Lifeguards perform in-water resuscitation more effectively and efficiently than laypersons.

The American Red Cross Scientific Advisory Council review ([American Red Cross Scientific Advisory Council Resuscitation 2019](#)) concluded that although the evidence is limited, in-water resuscitation is feasible but difficult, and can be physically and metabolically taxing to a rescuer, particularly if the rescuer is not properly trained nor physically fit. Physical and metabolic demands and rescue time can be decreased with the use of rescue equipment. A 2023 International Liaison Committee on Resuscitation systematic review ([Barcala-Furelos et al. 2022](#); [Bierens et al. 2023, 100406](#)) of in-water resuscitation included the same retrospective observational study ([Szpilman and Soares 2004, 25](#)) reviewed in the 2022 American Red Cross Scientific Advisory Council review and concluded that in-water resuscitation (i.e., with ventilations only) may be considered in situations where a trained rescuer determines that the rescuer safety, equipment available and distance to shore warrant its use.

## Insights and Implications

Because airway and respiratory pathophysiology, including systemic hypoxemia, are the most significant insults and primary cause of morbidity and mortality in the drowning process, the earlier an intervention can be applied to reverse the insult and the drowning process, the greater the chances should be for survival. However, the evidence to support in-water ventilation is limited, shows that it increases the time and difficulty of the rescue and it may lead to increased water aspiration by the drowning person. In-water ventilation is considered feasible in suitable water conditions by highly-trained rescue teams with water rescue equipment if the distance to shore warrants its use. Thus, it should only be considered if the responder has proper training, can provide in-water resuscitation without causing an unsafe environment and floating and propelling equipment can be used.

In-water ventilations while swimming or towing are not taught by Red Cross for multiple reasons, including:

- Loss of a tight mask seal during the rescue process.
- Difficulty maintaining an open airway while swimming.
- Potential entry of water into the airway.
- The relatively short distance to an extrication point in the pool environment.
- The potential for delayed extrication and resuscitation on land.

In-water ventilations in a stationary position are taught by the Red Cross for situations where extrication is delayed.

## Resuscitation on a Boat Following Drowning

**Last Full Review: ILCOR 2023**

Rescue boats are used by many lifeguard and rescue organizations to respond to drowning events in open water. Some rescue boats have trained crews, protocols and equipment to begin on-board resuscitation from the drowning process. After retrieving an unresponsive person from the water and onto a rescue boat, should the patient be transported to dry land immediately and thus delay resuscitation, or should resuscitation be initiated on-board and during transportation?

### Red Cross Guidelines

- Resuscitation from drowning may be performed on a boat if conditions are safe and there are adequately trained responders to assist.

### Evidence Summary

There are no human studies evaluating immediate resuscitation onboard a boat compared with delaying resuscitation until resuscitation can be performed on dry land. A systematic review by the International Liaison Committee on Resuscitation (ILCOR) ([Barcala-Furelos et al. 2022](#); [Bierens et al. 2023, 205](#)) led to a good practice statement suggesting that on-boat cardiopulmonary resuscitation (CPR) may be delivered if

rescuers trained in this technique determine that it is feasible and safe to attempt resuscitation. If rescuers feel that the application of immediate CPR is or becomes too difficult or unsafe, then the rescuers may delay resuscitation until on dry land. Previous scoping reviews by ILCOR ([Bierens et al. 2023, 205](#); [Wyckoff et al. 2022, e483](#); [Wyckoff et al. 2022, e645](#)) have identified manikin studies and case series of resuscitation on a boat. The manikin studies evaluated CPR performance by lifeguards and fishermen on inflatable rescue boats or traditional fishing boats and found that while feasible, higher boat speed or sea conditions negatively impact the quality of resuscitation and make CPR physically demanding.

A case series with a total of 37 patients who received CPR by lifeboat crew reported survival at 1 month in three (8.1%) cases ([Seesink, Nieuwenburg, van der Linden and Bierens 2019, 104](#)). Studies evaluating the use of an automated external defibrillator (AED) on a rescue boat show that their use is feasible (de Vries, Bierens and Maas 2006, 247). Automated external defibrillators are used in 5% to 32% of drowning events before the arrival of emergency medical services (EMS) and a shockable rhythm is present in only 2% to 14% ([Bierens et al. 2023, 100406](#); [Wyckoff et al. 2022, e483](#); [Wyckoff et al. 2022, e645](#)). In the case series by Seesink et al ([Seesink et al. 2019, 104](#)), an AED was connected in just over half of the resuscitations (19/37, 51.3%), including 12 (32.4%) on a lifeboat. None of the 12 patients survived, although this may partly reflect the time from initial call to the connection of the AED. Reasons for not using an AED onboard included circumstances such as weather, challenging sea conditions or proximity to shore that led to a decision to proceed immediately to dry land and waiting ambulance crews ([Seesink et al. 2022, 53](#)).

## Insights and Implications

The rationale for immediate resuscitation of a drowning person on a boat, or in water with ventilations only, is the rapid reversal of hypoxia and the hypoxic nature of cardiac arrest in the drowning process. Manikin studies suggest that resuscitation on board a boat is feasible if conditions are safe and the number of available crew and deck pace permit. However, high-quality CPR may be difficult to provide and rescuer fatigue may easily occur. Other factors to be considered by organizations that provide onboard resuscitation include the:

- Size, speed and stability of the rescue boat.
- Deck surface and size.
- Weather, including sea or water conditions.
- Boat operator skill.
- Rescuer skills training and level of physical fitness.
- Distance from the boat to dry land.
- EMS assistance.

# Ventilations With and Without Equipment for Drowning Process Resuscitation

**Last Full Review: ILCOR 2023; American Red Cross Scientific Advisory Council 2017**

Cardiac arrest in the drowning process is primarily the result of hypoxia, in contrast to adult cardiac arrest, which is primarily of cardiac origin. This has led to questions regarding the approach to airway management and ventilations in resuscitation from the drowning process.

## Red Cross Guidelines

- A single rescuer providing ventilations should use the mouth-to-mask technique, rather than the bag-mask technique.
- Multiple rescuers providing ventilations may use the two-person bag-mask technique, if properly trained and experienced in this method.
- Opening the airway and delivering rescue breaths or manual ventilations should not be delayed for suctioning of the oral airway. If ventilations or breaths cannot be delivered, begin chest compressions, then look in the mouth before attempting ventilations to check for visible and easily removed foreign bodies.

## Evidence Summary

There are no studies of adults and children in cardiac arrest following drowning that directly compare providing ventilation using equipment (e.g., a bag-valve-mask device, supraglottic airway or endotracheal tube) with providing ventilations without equipment. A systematic review by the International Liaison Committee on Resuscitation (ILCOR) ([Abelairas-Gómez et al. 2022](#); [Berg et al. 2023, e187](#); [Bierens et al. 2023, 100406](#)) identified indirect evidence from a study ([Ryan et al. 2021, 130](#)) comparing outcomes following the use of a supraglottic (advanced) airway compared with the use of bag-mask ventilation. A lower odds of survival to hospital admission was reported following the use of a supraglottic airway compared with bag-mask ventilation (aOR, 0.40; 95% CI, 0.19–0.86). Worse outcomes were also identified in studies in children with intubation by emergency medical services professionals compared with bag-

mask ventilation (OR, 0.04; 95% CI, 0.01–0.20) (Joanknecht et al. 2015, 123) and OR, 0.25 (95% CI, 0.08–0.83) (Kieboom et al. 2015, H418) respectively. No evidence was identified to suggest a change from current recommendations for Basic Life Support (BLS) and Advanced Life Support guidance for lay persons or for BLS providers and healthcare professionals. The indirect evidence was considered by the ILCOR review authors in making a good practice statement that bag-mask ventilation can be used by lifeguards or other BLS providers with a duty to respond, on the condition that it is part of a competency-based training program with regular retraining and maintenance of equipment.

A good practice statement was also made by ILCOR recommending the use of mouth-to-mouth, mouth-to-nose or pocket-mask ventilations by BLS providers and laypersons for adults and children in cardiac arrest caused by drowning. Healthcare professionals should follow normal guidelines for airway management and ventilation of adults and children in cardiac arrest caused by drowning (Abelairas-Gómez et al. 2022; Berg et al. 2023, e187).

A 2008 American Red Cross Advisory Council scientific review (American Red Cross Advisory Council 2008), updated in 2021, (American Red Cross Scientific Advisory Council 2021) evaluated the use of ventilation with a bag-valve-mask device versus mouth-to-mask for a single-rescuer or multiple rescuers caring for a nonbreathing person. The review included 14 studies comparing ventilation techniques. One randomized controlled trial (Adelborg et al. 2011, 618) included 60 lifeguards and found that mouth-to-mask ventilation was the most effective technique in that they provided the most effective ventilation and had the least interruptions during chest compressions.

A study (Paal et al. 2008, 42) evaluating retention of ventilation skills using mouth-to-mouth, mouth-to-mask and mouth-to-face shield reported skill retention to be highest at 1 year for mouth-to-mask, while ventilation using a bag-valve-mask device had the highest risk of hyperinflation. All studies included in this review were performed using manikins and the certainty of evidence low to very low. The review concluded that ventilation by mouth-to-pocket mask is the best technique to teach lay providers to ventilate nonbreathing patients. Ventilation using a bag-valve-mask device appears more difficult to learn and retain.

## Insights and Implications

The hypoxic mechanism of cardiac arrest in drowning supports recommendations for the use of cardiopulmonary resuscitation with ventilations or rescue breaths. For bystanders and lay rescuers, this can be accomplished with mouth-to-mouth, mouth-to-nose or pocket-mask ventilation. Lifeguards and those with a duty to respond are frequently trained in the technique of bag-mask-ventilation. Because it is difficult to obtain a good mask seal while ventilating with a bag-valve-mask device, the Red Cross recommends only using this technique when there are multiple rescuers, with one person controlling the

mask seal while another delivers ventilations using the bag. In most cases a single rescuer will find mouth-to-mask ventilations easier and more effective than bag-mask-ventilation.

## Prehospital Oxygen Following Drowning

**Last Full Review: ILCOR 2023**

There are no studies on supplemental oxygen use by lifeguards in drowning process resuscitation. However, the pathophysiology of the drowning process, including decreased oxygen diffusion capacities of the lungs following aspiration of water, provides a rationale for the administration of oxygen, when available, to persons with respiratory symptomatology following a drowning event.

When should lifeguards provide oxygen following a drowning event?

### Red Cross Guidelines and Best Practices

- If available, supplemental oxygen may be provided empirically by responders trained in its use to adults and children who are conscious and with respiratory symptoms following a drowning event. Once pulse oximetry is available, supplemental oxygen therapy should be appropriately titrated.
- For adults and children with cardiopulmonary arrest following drowning, supplemental high-flow and high-concentration oxygen, if available, should be provided with ventilations by responders trained in its use.

### Evidence Summary

A 2023 systematic review (Bierens et al. 2023, 100406) and Consensus on Science with Treatment Recommendations (Seesink 2022, 53; Wyckoff et al. 2022, e483) by the International Liaison Committee on Resuscitation (ILCOR) sought literature to answer this question, in adults and children in cardiac arrest following drowning: Does oxygen administration before hospital arrival compared with no oxygen

administration before hospital arrival change survival outcomes or return of spontaneous circulation (ROSC)? No direct evidence was identified that addressed the question.

A good practice statement was made, that when available, ILCOR recommends trained providers use the highest possible inspired oxygen concentration during prehospital resuscitation for adults and children in cardiac arrest following drowning. In making this statement, the authors noted that:

- Hypoxemia is associated with worse outcomes.
- Prompt initiation of bystander cardiopulmonary resuscitation (CPR) is associated with better outcomes in drowning.
- The use of supplemental oxygen, when available during and after CPR, is an accepted practice in drowning resuscitation and other circumstances.

However, there is evidence that prolonged administration of high-concentration oxygen may be harmful, and there are no adult human studies comparing maximal inspired oxygen with another inspired oxygen concentration in CPR ([Seesink et al. 2022, 53](#); [Wyckoff et al. 2022, e483](#)). It was also noted that adding oxygen to resuscitation algorithms could increase their complexity, and it is recommended that oxygen use be limited to providers who are trained and practiced in its use during resuscitation.

There is uncertainty about the effectiveness of oxygen in early stages after drowning, and the high-cost/low-benefit balance does not favor the use of pulse oximetry during resuscitation. Finally, it was noted that following ROSC, recommendations should be followed for oxygen titration ([Seesink et al. 2022, 53](#); [Wyckoff et al. 2022, e483](#)).

## Insights and Implications

The new ILCOR systematic review, while not identifying direct evidence, describes the rationale behind their good practice statement and has been used to inform the Red Cross guidelines. The Red Cross guidelines reflect that responders who use oxygen must receive training in oxygen administration. When trained lifeguards and responders administer oxygen to adults or children without cardiac arrest but with respiratory distress or failure following a drowning process event, oxygen should be titrated once pulse oximetry is available and a reliable reading can be obtained.