# ACFAS Scientific Review
# Sub diaphragmatic Thrusts and Drowning Victims

**Questions to be addressed:**

After removing a person in respiratory or cardiac arrest from the water, what is the first step a first responder should carry out?

**Introduction/Overview:**

The International Liaison Committee on Resuscitation (ILCOR) conducts a scientific evidence review and the American Red Cross (ARC) uses this review as one of the sources to provide Guidelines for Emergency Care and Education which apply but are not limited to people in respiratory or cardiac arrest. The 2005 Guidelines for Emergency Care and Education state if a victim is in cardiac arrest, the rescuer should begin CPR immediately. If, after repositioning the patient's airway ventilation efforts are not effective, the rescuer should try to clear the airway by using age-appropriate methods for relieving a solid foreign body. The ILCOR evidence evaluation is supported by multiple professional and scientific organizations including the American Academy of Pediatrics, the American College of Cardiology, and the American College of Emergency Physicians and the Institute of Medicine of the National Academy of Sciences.

Despite consensus which is part of the ILCOR scientific evidence review process, Henry J. Heimlich MD, has advocated that when treating drowned people, subdiaphragmatic abdominal thrusts should be tried before CPR is given. Dr. Heimlich asserts aspirated water obstructs the patient's airway and significantly hinders ventilation of the lungs. He argues subdiaphragmatic abdominal thrusts will relieve the alleged airway obstruction, remove water from the patient's lungs, and should be continued until no water or fluid flows from the patient's mouth.

Physiology of Drowning:

The sequence of events that occurs following water aspiration into the lungs is a patho-physiologically complex process. The aspiration of water includes laryngospasm, fluid shifts across the pulmonary alveolar membrane, destruction of surfactant, atalectasis, intrapulmonary shunting, and pulmonary edema formation.

**Review Process and Literature Search Performed**

The titles and abstracts of 117 citations were retrieved using a computerized search of the National Library of Medicine Medline database from 1966 to 2005. MeSH heading combinations of "drowning" or "near-drowning" with "Heimlich maneuver" were used as search features. The abstracts of all citations were analyzed and those suitable for full review were obtained. Manual search of the reference lists from these articles was also conducted for added relevant citations. This process resulted in the review of 27 citations of which 18 (all class III) were found to discuss the role of the Heimlich maneuver to treat drowned people. In addition, Dr. Heimlich's website was searched for scientific articles supporting his position.

Revision Approved by ACFAS November 9, 2006
Original Statement Approved 2000

**Scientific Foundation:**

a. Original ACFAS Scientific Review

Heimlich[1] states that near-drowning victims aspirate large amounts of water and that the water causes obstruction of the airway. He advocates that the safest and most effective method for removing water from the lungs of a near-drowning victim is the subdiaphragmatic abdominal thrust (Heimlich maneuver). He states that this maneuver should be the first step in the management of the near-drowning patient and should be repeated until no water or fluid flows from the patient's mouth. In order to minimize the risk of aspiration (which he believes to be low since the patient is not breathing and will not inhale any vomitus), the head of the patient should be turned to one side and/or on a reverse incline such as a sloping shore so the patient can be placed in a head down position. Heimlich cites several anecdotal case reports, including one involving an aspirated piece of vegetable, to support his opinion.[2,3]

There is no scientific literature available supporting the concepts that near-drowning victims aspirate large volumes of water, that aspirated water obstructs the airway of near-drowning victims, that the water must be removed immediately upon rescue of the patient, or that the Heimlich maneuver (abdominal thrust) is an effective and safe method for removing aspirated water from the airway and lungs.

Modell[4] in a review article reported that 15% of near-drowning patients have no evidence of any water aspiration. The remaining 85% do aspirate some water, up to 22 milliliters per kilogram of body weight, although he stresses that in many cases the amount is much less than the 22 ml/kg.[5] He points out that one would expect electrolyte abnormalities in patients who have aspirated large amounts of water. In actuality, these changes are rarely found, thus suggesting that aspiration of large amounts of water does not occur. Modell recommends immediate airway control and initiation of ventilation and correction of hypoxemia.[6] Simcock also reported that many patients of near-drowning did not have any signs of aspiration of water, including some who appeared apneic when removed from the water.[7]

Rosen, chairing an expert committee for the Institute of Medicine (IOM), could find no evidence that water aspiration causes obstruction or prevents efforts to ventilate patients.[8] The IOM panel recommended that the current ECC guideline of establishing an airway and ventilation be the priority. Quan, in a study of submersion victims, reported no finding of airway fluid to impair paramedics' ability to intubate nor any difficulty in ventilating patients once intubated.[9,10]

The sequence of events which occurs following water aspiration into the lungs includes laryngospasm, fluid shifts across the pulmonary alveolar membrane, destruction of surfactant, atalectasis, intrapulmonary shunting, and pulmonary edema formation. Weinstein et al[11] point out the final pathophysiologic result of near drowning is hypoxemia. As was stated in the IOM report, there is no evidence in any study that removing water from the lungs will alter this sequence of events.

Numerous other authorities have also recommended that obtaining an airway, ventilating the patient and correcting hypoxemia are the immediate treatment priorities.[12,13,14,15]

Weinstein et al point out that no study has demonstrated that the Heimlich maneuver can result in the removal of significant amounts of fluids from the lungs of these patients. He also raises the

concern that an abdominal thrust may cause vomiting. This vomitus could then interfere with efforts to ventilate the patient or may result in aspiration and further deterioration of the pulmonary status. Others have also echoed the concerns about inducing regurgitation or vomiting.,[16] Finally Weinstein also voices the concern that efforts to perform the Heimlich maneuver delay the establishment of an airway, ventilation and correction of hypoxemia.

The recommendation by Heimlich that the victim's head be turned to the side to facilitate drainage of fluid expelled as a result of performing the Heimlich maneuver has also raised concerns about the potential for exacerbation of a possible cervical spine injury in some patients.

b. ACFAS Re-evaluation of Scientific Data

An expert committee for the Institute of Medicine of the National Academy of Sciences recommended the ECC guideline of setting up an airway, immediately beginning ventilations, followed by chest compressions remain the first responder's treatment sequence. Safar, Escarraga & Chang (1959) found an improperly opened airway was the most common causes of airway impediment. Rosen, Stoto, & Harley (1995) could not find evidence that water aspiration causes an airway obstruction or prevents efforts to ventilate patients.

The work of Neal (1985), Ornato (1986), Modell (1986), Olshaker (1992), Brass (1995), and Weinstein & Krieger (1996) supported immediate airway control, introduction of ventilation, and correction of hypoxemia as the treatment priorities for drowned people. Lanhelle (2000) study of cadavers with a simulated complete airway obstruction has shown that chest compressions created a greater mean airway pressure than what was achieved with sub-diaphragmatic thrusts. One can derive from this study that chest compressions generate greater force for removing foreign body airway obstructions than sub-diaphragmatic thrusts.

Simcock (1986) reported that many people who appeared apneic when removed from the water did not have any signs of aspiration of water. Quan (1990, 1993) found no evidence that airway fluid either hindered paramedics' ability to intubate a drowned person or presented any difficulty in these patients once intubated.

Orlowski (1987) noted concerns that the use of the Heimlich maneuver could induce regurgitation. Weinstein & Krieger (1996) also argued abdominal thrusts may cause vomiting, which would then interfere with efforts to ventilate the patient, and may result in aspiration of stomach contents.

Since water in the airways or lungs of drowned people is not considered a solid object airway barrier, subdiaphragmatic abdominal thrusts should not be given to drowned person by a first responder.

**Summary:**

There is compelling evidence to support a treatment standard.

The first step after removing a drowned person from the water should be to obtain an airway, start rescue breathing and deliver cardiac compressions. The 2005 American Red Cross Guidelines for Emergency Care and Education provide one approach to patients with airway, respiratory and cardiac emergencies without variation for the techniques applied to the near drowning patient. The one exception is the insertion of a step for removal from the water.

Studies have shown that there is no need to clear the airway of aspirated water. Only a modest amount of water is aspirated by the majority of drowning victims and it is rapidly absorbed into the central circulation. Therefore, it does not act as an obstruction in the trachea (Institute of Medicine Report Rosen, Stoto, & Harley, 1995). It has also been shown that some victims do not aspirate fluid because they develop laryngospasm or experience breath-holding (Modell, 1993). An attempt to remove water from the breathing passages by any means other than suction (e.g., abdominal thrusts or the Heimlich maneuver) are unnecessary and potentially dangerous (Institute of Medicine Report, Rosen Stoto, & Harley, 1995).

The routine use of abdominal thrusts for drowning victims is not recommended. The 2005 guidelines also eliminated the phrase "Heimlich maneuver" and replaced it with the more descriptive "abdominal thrust."

**Recommendations and Strength:**

**Standards:** Manage a drowned person victim with airway, breathing or circulatory problems the same as any other patient with airway breathing or circulatory problem. The one variation being the need for removal from the water as part of the care rendered.

**Guidelines:** Manage drowned child or infant with airway, breathing or circulatory problems the same as any other patient with airway breathing or circulatory problem. The one variation being the need for removal from the water as part of the care rendered

**Options:**

**Overall Recommendation:**

Subdiaphragmatic abdominal thrusts are neither effective nor safe methods for attempting water removal from the airway or lungs of drowned people. No scientific literature supports the idea that aspirated water obstructs these patient's airways thus hindering ventilations. Since no scientific study has shown water can be removed from drowned people's airways or lungs through subdiaphragmatic abdominal thrusts the 2005 COSTR Guidelines remain the CPR treatment standard for drowned people.

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Original Statement Approved 2000

**Summary of Key Articles/Literature Found and Level of Evidence/Bibliography:**

The following studies found that obtaining an airway, ventilating the patient, and correcting hypoxemia were the immediate treatment priorities for drowned people. These experts contended performing subdiaphragmatic abdominal thrusts prolonged establishment of an airway, delayed ventilations of a patient's lungs, might induce regurgitation, and could lead to aspiration of stomach contents. The only exceptions to these treatment priorities were the articles written by Dr. Heimlich (1979, 1981 an 1988).

| Author(s) | Full Citation | Summary of Article | Level of Evidence (Using table below) |
|---|---|---|---|
| Heimlich, HJ 1981 | Subdiaphragmatic pressure to expel water from the lungs of drowning persons. Ann Emerg Med 1981;10:476- | General description and rationale for performing the maneuver. | 7 |
| Heimlich HJ, Uhley MH 1979 | The Heimlich Maneuver. Clin Symposia 1979; 31: 3-32. | General review of the maneuver primarily for the choking victim, gives a few anecdotal case reports on near drowning. | 3b |
| Heimlich HJ, Patrick EA.1988 | Using the Heimlich maneuver to save near-drowning victims. Postgrad Med 1988; 84:62-73. | The first step in resuscitation of the near-drowning victim is to initiate ventilation and circulation. No evidence exists to confirm efficacy of abdominal thrusts. | 3b |
| Modell, JH | Drowning. N Engl J Med 1993; 328:253-256. | Responds that the Heimlich maneuver should be reserved for those instances where a patient cannot be ventilated and airway obstruction is suspected. | 7 |
| Modell, JH 1986 | Near Drowning. Circulation 1986; 74 (suppl IV): 27-28. | The first step in resuscitation of the near-drowning victim is to initiate ventilation and circulation. The Heimlich should only be performed if the patient cannot be ventilated. | 7 |
| Simcock, 1986 | Treatment of near drowning – a review of 130 cases. Anaesthesia 1986; 41:643-648. | Many patients had no evidence of aspiration. | 2b |

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| Rosen P, Stoto M, Harley J. 1995 | The use of the Heimlich maneuver in near drowning: Institute of Medicine report. J Emerg Med 1995; 13:397-405. | No evidence was found documenting massive aspiration causing airway obstruction or the usefulness of the Heimlich maneuver in near drowning. The first step in resuscitation of the near drowning victim is to initiate ventilation and circulation. | 6 |
| Quan, L 1993 1993 | Drowning issues in resuscitation. Ann Emerg Med 1993; 22 (pt 2): 366-369. | Recommends against using Heimlich maneuver as the first step in resuscitation of near-drowning victims. | 7 |
| Quan L, Wentz KR, Gore E, et al.1993 | Drowning issues in resuscitation. Ann Emerg Med 1993; 22 (pt 2): 366-369. | Prehospital care providers had no difficulty ventilating submersion victims. | 2a |
| Weinstein MD, Krieger BP. 1996 | Near-drowning: Epidemiology, pathophysiology, and initial treatment. J Emerg Med 1996; 14:461-467. | No evidence to support Dr. Heimlich's opinion of the efficacy of the maneuver to expel fluid from the lungs of near drowning victims. | 2b |
| Olshaker, JS 1992 | Near Drowning. Emerg Med Clinics N Amer 1992; 10:339-350. | The first step in resuscitation of the near-drowning victim is to initiate ventilation and circulation. | 2b (Literature review) |
| Neal, JM 1985 | Near-drowning. J Emerg Med 1985; 3:41-52. | Notes that virtually all experts in near drowning recommend that the first step in resuscitation of the near-drowning victim is to initiate ventilation and circulation; only Heimlich recommends the use of the maneuver. | 2b (literature review) |
| Bross MH, Clark JL, 1995 | Near-drowning. Amer Fam Phys 1995; 51:1545-1551. | The first step in resuscitation of the near-drowning victim is to initiate ventilation and circulation. The Heimlich maneuver should be reserved for those cases with documented airway obstruction. | 2b (Literature review) |

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| Ornato, JP, 1986 | Special resuscitation situations: near drowning, traumatic injury, electric shock, and hypothermia. Circulation 1986; 74 (suppl IV): 23-26. | The recommendation was to use the Heimlich for those cases with documented airway obstruction. | 6 |
| Safar, P., Escarraga, L.A. &Chang, F 1959. | Upper airway obstruction in the unconscious patient. *J Appl Physiol* 14: 760-764, 1959; | Airways were obstructed in 80 anesthetized, spontaneously breathing patients, both in the supine and prone positions. When the neck was flexed and the mandible was not held forward the tongue was pushed against the posterior pharyngeal wall. The frequency and degree of obstruction was similar in the prone and supine positions, with comparable positions of the head, neck and mandible. | 1b |
| Langhelle, A, Sunde, K, Wik L, Steen, PA, 2000. | Airway pressure with chest compressions versus Heimlich maneuver in recently dead adults with complete airway obstruction. Resuscitation 2000; 44:105-108 | In a randomized crossover design standard chest compressions and Heimlich maneuvers were performed on 12 cadavers with a simulated complete airway obstruction The mean peak airway pressure was significantly higher with chest compressions compared to abdominal thrusts. | 4 |
| Orlowski, JP 1987 | Vomiting as a complication of the Heimlich maneuver. JAMA 1987; 258:512-513. | Vomiting after the Heimlich maneuver can cause serious complications. The first step in resuscitation of the near-drowning victim is to initiate ventilation and circulation. The Heimlich maneuver should be reserved for those cases with documented airway obstruction. | 3b |
| American Red Cross, 2005 | 2005 Guidelines for Emergency Care and Education: Unconscious person | If chest does not rise after two rescue breaths, re-tilt head and administer two more rescue breaths. If chest still does not rise give chest compressions and look inside person's mouth. If object is seen remove from person's mouth. If no object is seen give two rescue breaths. If chest does not ride, give 30 chest compressions. | 6 |

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| American Red Cross, 2005 | 2005 Guidelines for Emergency Care and Education: Conscious person | Confirm person is choking, obtain consent, and give 5 back blows. If the person is still choking give 5 abdominal thrusts. If the person is still choking administer 5 back blows. | 6 |
| International Liaison Committee on Resuscitation | 2005 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations, Part 2: Adult Basic Life Support, Circulation 2005: 112 (Suppl III) III-6.) | It is unclear which method of removal of FBAO should be used first Life threatening complications have been associated with the use of abdominal thrusts (23 cases). | 6 |

| Level of Evidence | Definitions |
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| **Level 1a** | Population based studies, randomized prospective studies or meta-analyses of multiple studies with substantial effects |
| **Level 1b** | Large non-population based epidemiological studies or randomized prospective studies with smaller or less significant effects |
| **Level 2a** | Prospective, controlled, non-randomized, cohort or case-control studies |
| **Level 2b** | Historic, non-randomized, cohort or case-control studies |
| **Level 2c** | Case series: convenience sample epidemiological studies |
| **Level 3a** | Large observational studies |
| **Level 3b** | Smaller observational studies |
| **Level 4** | Animal studies or mechanical model studies |
| **Level 5** | Peer-reviewed, state of the art articles, review articles, organizational statements or guidelines, editorials, or consensus statements |
| **Level 6** | Non-peer reviewed published opinions, such as textbook statements, official organizational publications, guidelines and policy statements which are not peer reviewed and consensus statements |
| **Level 7** | Rational conjecture (common sense); common practices accepted before evidence-based guidelines |
| **Level 1-6E** | Extrapolations from existing data collected for other purposes, theoretical analyses which are on-point with question being asked. Modifier E applied because extrapolated but ranked based on type of study. |

[1] Heimlich HJ. Subdiaphragmatic pressure to expel water from the lungs of drowning persons. Ann Emerg Med 1981;10:476-480.
[2] Heimlich HJ, Uhley MH. The Heimlich Maneuver. Clin Symposia 1979;31:3-32.
[3] Heimlich HJ, Patrick EA. Using the Heimlich maneuver to save near-drowning victims. Postgrad Med 1988;84:62-73.
[4] Modell JH. Drowning. N Engl J Med 1993;328:253-256.
[5] Modell JH. Drowning (letter response). N Engl J Med 1993;329:65.
[6] Modell JH. Near Drowning. Circulation 1986;74 (suppl IV):27-28.
[7] Simcock AD. Treatment of near drowning – a review of 130 cases. Anaesthesia 1986;41:643-648.
[8] Rosen P, Stoto M, Harley J. The use of the Heimlich maneuver in near drowning: Institute of Medicine report. J Emerg Med 1995;13:397-405.
[9] Quan L. Drowning issues in resuscitation. Ann Emerg Med 1993;22 (pt 2):366-369.
[10] Quan L, Wentz KR, Gore E, et al. Outcome and predictors of outcome in pediatric submersion victims receiving prehospital care in King County, WA. Pediatrics 1990;86:586-593.
[11] Weinstein MD, Krieger BP. Near-drowning: Epidemiology, pathophysiology, and initial treatment. J Emerg Med 1996;14:461-467.
[12] Olshaker JS. Near Drowning. Emerg Med Clinics N Amer 1992;10:339-350.
[13] Neal JM. Near-drowning. J Emerg Med 1985;3:41-52.
[14] Bross MH, Clark JL. Near-drowning. Amer Fam Phys 1995;51:1545-1551.
[15] Ornato JP. Special resuscitation situations: near drowning, traumatic injury, electric shock, and hypothermia. Circulation 1986;74 (suppl IV):23-26.
[16] Orlowski JP. Vomiting as a complication of the Heimlich maneuver. JAMA 1987;258:512-513.

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