

Management of drowning in children

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Abstract

Drowning has historically been a significant cause of morbidity and mortality in children. It characteristically affects unsupervised toddlers and thrill-seeking teenagers. Through prevention rather than treatment we have seen a tremendous reduction in the number of drowning victims, although in less well-developed countries, which are less able to provide education and enforce safety measures, the burden remains large. In the developed world domestic pools remain a risk. The international community has agreed on a definition of drowning as 'the process of experiencing respiratory impairment from submersion or immersion in a liquid'. This replaces all previous terms including 'near drowning'. If prevention has failed, survival from drowning is dependent on immersion time, on-scene resuscitation and subsequent intensive care management. The critical problem is hypoxia and this must be relieved as soon as possible if there is to be a favourable outcome. Extraction should not put the rescuers at risk but should be as quick as possible so that resuscitation can commence. Intensive care management can further improve outcomes, although further doubt has been cast on the role of therapeutic hypothermia following cardiac arrest. Of all the causes of paediatric out-of-hospital cardiac arrests it must be borne in mind that those secondary to drowning have the best outcomes.

Keywords drowning; hypoxia; out of hospital cardiac arrest (OOHCA); prevention; therapeutic hypothermia

Introduction

Historically drowning has been a significant cause of death worldwide, with a particular impact on the paediatric population. Although there has been a reduction in hospital admissions and deaths from drowning in developed countries, it is still the commonest cause of traumatic death in the one to four year age group and the second commonest in the one to 16 year age group. There remain significant global inequalities; in the poorer parts of southern and eastern Europe there have been absolute improvements in mortality but the relatively greater improvement in western Europe means that the gap is actually widening. In developing countries the incidence remains high and drowning has, at 10%, the highest fatality rate for all injuries

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presenting to the emergency department. There is a high chance that survivors will have significant neurological impairment and given their young age this represents a prolonged whole-life burden on them, their families and society. The global burden, the personal impact and the tragedy of failed prevention means that fear of drowning remains a concern in the public imagination as well as within public health.

If one reads reviews of the management of near drowning from 30 years ago, much of the information and advice is the same as it would be today. The first significant difference that warrants discussion is the terminology. A uniform approach to reporting of data was reached in the 'Utstein style', a process initially developed to harmonise the reporting of out-of-hospital cardiac arrest, at the 2002 World Congress on Drowning. This definition which has been endorsed by the International Liaison Committee on Resuscitation (ILCOR) states that drowning is 'the process of experiencing respiratory impairment from submersion or immersion in a liquid'. The intention is to exclude innocuous episodes of immersion/submersion but to include all other events whatever the aetiology or outcome. The terms wet drowning, dry drowning, active or passive drowning, near-drowning, secondary drowning, and silent drowning should therefore all be discarded. This simplification of reporting not only improves reporting but clarifies thinking on the management of drowning as the emphasis on different types of drowning is removed.

Prevention

Characteristically infants drown in baths, toddlers drown in ponds and unfenced pools and teenagers drown in open water often under the influence of alcohol; this is still the pattern of drowning in the UK and avoidance is still the focus of its management. The extraordinary reduction in drowning and its consequences in developed countries can be partly attributed to better resuscitation, faster extraction and improved hospital care but it is overwhelmingly the result of increased prevention. This encompasses, including others, bath supervision, learning to swim, safe policing of swimming pools, management of drug and alcohol use and domestic pool safety.

Every drowning represents the failure of prevention. It is estimated that more than 85% of cases of drowning can be prevented by supervision, swimming instruction, technology, regulation, and public education. In the UK, the Royal Society for the Prevention of Accidents (RoSPA) actively campaigns to improve water safety education and awareness, through such initiatives as the Water Safety Code.

Education, publicity and regulation have an important role to play particularly for risk groups; such as babies, toddlers and those with other vulnerabilities. The risk of drowning in people with epilepsy is raised 15- to 19-fold compared with people in the general population. It is important that people with epilepsy and their carers be informed of these risks so that deaths can be prevented. Simple measures that can reduce the morbidity and mortality associated with drowning are listed in [Box 1](#).

Rescue and resuscitation

Optimal pre-hospital care is a significant determinant of outcome in drownings worldwide. The person called on to rescue and

Recommendations for water safety

Learning how to swim should be a priority for all children and for people of all ages.

A home swimming pool should always be fenced and secure. Motion detectors may be helpful should the fence fail to keep out unsupervised children.

When participating in water sports, the use of a personal flotation device (life jacket) is mandatory. Pool toys are not a substitute.

Alcohol is a major contributor to drowning accidents. Water and alcohol don't mix.

Never leave an infant unattended in a bath tub or near water.

Never leave a child unattended near water, whether that is a swimming pool or natural water.

Know where you are swimming:

Make certain the depth is at least 10 feet if you decide to dive into water.

Know about the dangerous undercurrents and waves that occur in fresh or sea water.

Avoid dangerous marine animals such as jellyfish and fire coral.

Know the depth of ice before walking on it.

Never swim alone.

Learn CPR.

Box 1

resuscitate the drowned child may be a trained life-guard or member of the emergency medical services or more likely a family member or a passer-by. Understanding the threat to the patient informs subsequent actions. The principle threat is hypoxia. The victim should therefore be removed from the water as soon as possible and breathing should be assessed and if necessary assisted. The aim is to prevent the hypoxic insult progressing to organ damage and cardiac arrest or to remove the state of hypoxia to allow the return of spontaneous cardiac output. Despite the fact that these arrests are frequently asystolic and infrequently witnessed, they have a relatively favourable outcome compared to other causes of out-of-hospital (OOH) cardiac arrest.

The determinants of survival in out-of-hospital cardiac arrests secondary to drowning are duration of submersion, time to basic life support, duration of Cardiopulmonary Resuscitation (CPR) before return of spontaneous circulation (ROSC) and potentially the speed of rewarming. Infants and toddlers often drown in or around the home, as a result of a period of failed supervision. Location is therefore in their favour as they don't require extraction, but they do require basic life support. Parents need to respond appropriately with the institution of basic life support and attempts to obtain help. Bystander CPR is recognized to contribute to successful outcome in out-of-hospital cardiac arrest. Drowned children with documented apnoea are almost 5 times more likely to have a good neurological outcome if immediate resuscitation was commenced before the arrival of Emergency Medical Service (EMS) personnel. There is no data on the effectiveness of parental resuscitation from drowning and there is no data on the value of training parents in basic life support. However there are a number of programmes aimed at teaching basic life support to new parents, often of high risk

infants, with adequate retention of skills and no increase in parental anxiety. This approach is supported by the American Academy of Paediatricians with the additional advice that paediatricians should identify families with pools for additional advice and training.

As in any resuscitation, initial treatment should be geared toward ensuring adequacy of the airway, breathing, and circulation. The airway should be checked for foreign material and vomitus. Debris visible in the oropharynx should be removed with a finger-sweep manoeuvre. The abdominal thrust (Heimlich) manoeuvre has not been shown to be effective in removing aspirated water. In addition, it delays the start of resuscitation and risks causing the patient to vomit and aspirate therefore it should not be used.

For bystanders, particularly those who are not trained providers, it is important to consider the safety of all those involved. The primary aim is to get help and not to put the rescuer at risk. If a drowning person is conscious, they should be brought to land as soon as possible. This is best achieved without entering the water. Sticks, buoys, ropes and boats can all be used to aid rescue and avoid entering the water and should be sought. For a person who is unconscious, in-water-resuscitation may improve the chance of a favourable outcome by a factor of more than three, compared to taking the time to bring the person to dry land. As a consequence the European Resuscitation Council recommends in-water-resuscitation as part of aquatic rescue. However, this is only possible for a trained rescuer and can only really be performed with a buoyancy aid and ideally with ventilation adjuncts. It will often be quicker to get the victim directly to dry land and, even for a trained rescuer, it may be more effective to do so. Chest compressions are not possible because of buoyancy issues and should not be attempted in water.

Cardiopulmonary resuscitation guidelines now advocate that cardiac compressions alone are satisfactory in the initial resuscitation of most arrested patients. This is because there is satisfactory residual air in the lungs to adequately oxygenate the blood in the low flow state of CPR. However as cardiac arrest in drowning is almost always a *hypoxic event* and there is no residual lung air, rescue breathing should be performed. For similar reasons immediate CPR with a 'call fast' rather than 'call first' approach is recommended. Treatment of hypoxaemia is the key to the management of drowning. Oxygen should be administered as soon as it is available and ventilation should not be delayed if there is respiratory insufficiency. Bag-valve-mask (BMV) ventilation is as effective as tracheal intubation in preventing death and dispenses with the hazard of tube displacement. Endotracheal intubation at the scene is associated with lower organ injury though this may be a surrogate for other elements of advanced life support (ALS). Pre-hospital care delivered by physicians has significant implications for the organisation of health services but with the correct infrastructure a medical team has been shown to be deliverable to a drowning situation and have a significant impact on outcome.

Cervical spine trauma may be present in any victim of shallow or rocky water immersion injury. If the victim or witnesses are unable to give a clear history of the events, has evidence of head or facial injury, or is found unresponsive in a pool or other shallow body of water, protect the cervical spine until injury is

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