Drowning management and prevention

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BACKGROUND Accidental drowning causes over 300 deaths annually in Australia, and many more instances of 'near drowning'.
OBJECTIVE This article outlines the management of near drowning and the general practitioner's role in drowning prevention.
DISCUSSION Cardiopulmonary resuscitation (CPR) is the mainstay of immediate management. Continuing CPR for 30 minutes if necessary is appropriate, particularly in hypothermic patients. Patients who have been successfully resuscitated and those with clinical features suggesting aspiration should be given 100% oxygen and transferred to hospital. Drowning prevention is a significant public health issue, and the GP's role in education and support of rescue services and public awareness campaigns is important.

As summer approaches and the warm weather sets in, millions of Australians head to the water for a recreation break. While we associate family fun with the beach, river or the poolside, this can often be the scene of tragedy (*Figure 1*). Most important of these is drowning, which remains a significant cause of death for the Australian population.

Epidemiology

Over the period 1992–1998, 2199 people died in Australia from accidental drowning, including 343 who drowned as a result of watercraft accidents; an average of 314 deaths per year. The rate of drowning for all age groups was 1.5 per 100 000, with the highest rate in the under five years age group at 4.6 per 100 000.[1] The rates of drowning were higher in males than for females in all age groups, with four times as many males drowning (*Figure 2*). The circumstances of drowning are detailed in *Table 1*.

Drowning is seasonal, peaking in December to January, the hottest months and also the traditional holiday period. Antecedent factors include children aged 0–4 years, children living in cities with high swimming pool to population ratios, children living in hot climates, children living in areas with lack of isolation pool fencing, and indigenous children.[2]

Environmental factors include currents and rips, waves and colder water (see *Case 1*). Alcohol and drugs are commonly linked to drowning in men.[3] Medical illnesses such as myocardial infarction, epilepsy and cerebrovascular accident can play a role in the causation of drowning. Head trauma and cervical trauma from diving into shallow water are also associated with drowning. Water hazards such as irrigation canals, storm water drains, and farm dams pose a particular risk especially to children (see *Case 2*). Children under the age of 15 years made up 57% of farm drownings.[1]

Pathophysiology of drowning

In all drownings the sequence of events starts with panic and air hunger caused by holding of the breath. Reflex inspiratory efforts cause the patient to swallow water into the stomach and small amounts into the lungs. The aspiration of water causes laryngospasm leading to asphyxia. Loss of consciousness causes the muscles to relax and allows water to enter the lungs. The presence of

Figure 1. This apparently quiet stretch of beach was the scene of a protracted rescue attempt. The two rescuers survey the scene after having extracted an inexperienced surfer from the water, thankfully, with a favourable outcome. (Photo from the author's collection, 2003)

water in the lungs causes the development of a ventilation/perfusion mismatch which leads to systemic hypoxaemia.[4]

Drowning differs from other forms of cardiac arrest in that breathing ceases before cardiac arrest. Also as a result of the hypoxia, extreme metabolic acidosis develops. The progression of this status leads to cerebral oedema and acute tubular necrosis. Hypothermia frequently occurs in the setting of immersion. This can lead to a neuroprotective effect, especially in children.[4]

Management of near drowning

At the scene, resuscitation needs to be rapid, with cardiopulmonary resuscitation (CPR) the mainstay manoeuvre. Resuscitation should be continued for over 30 minutes, especially so if hypothermia is evident. All patients successfully resuscitated should be transferred to hospital by ambulance while breathing 100% oxygen.[5] It is essential to evaluate patients who are not as acutely unwell to determine if aspiration has occurred. Factors suggesting aspiration are listed in *Table 2*.

If any of the factors suggesting aspiration are present, the patient requires transfer to hospital on 100% oxygen. Once at hospital, the evaluation required includes arterial blood gas measurement, chest X-ray, electrolyte assay and an electrocardiogram (ECG). Regular monitoring of respiratory status, electrolytes and cardiac status is essential.

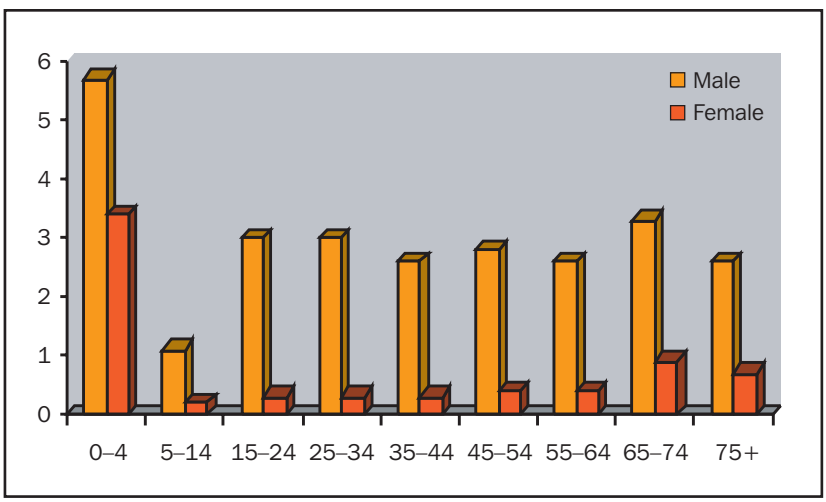

Figure 2. Age specific drowning rate by sex in Australia 1992-1998[1]

Table 1. Circumstances of accidental drowning in Australia 1992-1998[1]

Circumstance	Males	Females	Total persons	Percentage
Fell/wandered into water	561	187	748	34
Swimming/paddling/wading	503	97	600	27
Surfboard riding	19	1	20	1
Swept off rocks	78	13	91	4
Scuba diving	64	19	83	4
Drowned in bathtub	57	74	131	6
Attempting rescue	39	2	41	2
Watercraft accidents	325	18	343	16
Total	**1758**	**441**	**2199**	**100**

Case 1 – Harold Bult

After the tourist season, during an off duty period for the beach patrol, 67 year old Harold Bult stepped into a deep channel and a strong out-flowing rip directly in front of the surf clubhouse. He was witnessed to immediately submerge and sink under the surface. Rapid action by an off duty lifeguard had him extracted and on the beach in a matter of minutes. He was found to be blue, but immediately began spontaneous respiration. He vomited up copious seawater. Oxygen was administered from the surf club cylinder and an ambulance was called. He was transported to a nearby hospital where he was found to have widespread crackles on auscultation, pulse oximetry demonstrated an O_2 of 85%, and a chest X-ray was clear. In view of these findings he was transferred to a regional base hospital for intensive monitoring. He was discharged three days later and returned to the resort to complete his holiday.

This case demonstrates the false sense of security that even an out of season surf club can provide, the value of skills in rescue and resuscitation, the features of aspiration and the need for intensive monitoring.

Case 2 – Francis Agricola

While walking past the house dam, Sam Agricola noticed his two year old son Francis floating face down on the surface of the water. He quickly dragged him to the bank and started CPR. Using his mobile phone he was able to contact emergency services. Over the phone, he received further instruction in first aid procedures from the emergency coordinator. It was 20 minutes before a paramedic arrived and took over CPR from Sam. The child was intubated and commenced on 100% O_2. Spontaneous heartbeat resumed. The child was rapidly transported to the nearest hospital and immediately transferred to a tertiary paediatric centre.

Seven years later Francis is a strong, vibrant boy, with no apparent long term sequelae resulting from his 'near death' experience. This case demonstrates the risk of farm dams, the age of the 'usual' farm drowning, the use of CPR training, the value of modern telecommunications and skilled telephone triage, the effectiveness of advanced resuscitation, the apparent neuro-protective effect of hypothermia, and the value of prolonged resuscitation in children.

Table 2. Factors suggesting aspiration in near drowning[5]

Historical factors	Prolonged head immersion
	Impression of inhaling or choking
	Loss of consciousness
	Period of apnoea
	CPR required
Symptoms and signs	Cough
	Shortness of breath
	Retrosternal discomfort
	Cyanosis
	Tachycardia
	Tachypnoea
	Wheezes or crackles in chest
	Pink frothy sputum
	Reduced consciousness
	Reduced oxygen saturation (oximetry)

The role of the GP

As with any area of general community health and safety, the general practitioner can have a pivotal role in the prevention and management of drowning. Drowning is a good example of an injury that can be prevented by effective risk management. Armed with an understanding of the associated causes of drowning, it is possible to pursue a number of strategies for its prevention.

Education is an important strategy. This includes 'learn to swim' campaigns, community advice on water hazards and a focus on personal responsibility (ie. the use of alcohol and water safety). Training in CPR skills is helpful, as effective immediate resuscitation influences outcome.[5] The effectiveness of 'drown proofing' children under four years of age by the teaching of swimming skills is unproven.[6]

Preventive actions that promote hazard avoidance such as pool fences can be effective[6]; but all too often the gate is left open, rendering the fence useless. Dams and other water hazards on rural properties should be separated from the house by a child resistant fence. Bathrooms, laundries and garden ponds need effective barriers to prevent accidental drowning by an inquisitive toddler. Signs alerting of potential water hazards such as rips and currents are important additions to our surf beaches.[7]

The GP can play an important role in water safety by supporting the activities of the Royal Life Saving Society and the Surf Lifesaving Association. The role of these organisations in public education, signage of hazards and supervision of water activities has greatly assisted in the reduction of drowning deaths in Australia. Continued public health activism by GPs can contribute to a safer environment – for example, at the coastal resort of Lorne in Victoria, a GP pointed out to the foreshore development committee that the proposed relocation of a car park would put it next to a permanent rip, which was already the site of many beach rescues. Undoubtedly, if allowed to proceed, this relocation would have lead to even more rescues. Such environmental interventions, while differing from a GP's usual work, can change the actions of the various authorities involved in 'development' and lead to reductions in morbidity and mortality.[8]

SUMMARY OF IMPORTANT POINTS

- Accidental drowning causes over 300 deaths in Australia annually.
- Rapid resuscitation at the scene is vital.
- CPR should be continued for over 30 minutes if necessary, especially if hypothermia is evident.
- All patients successfully resuscitated (and those less unwell with features of aspiration) should be transferred to hospital and given 100% oxygen en route.
- GPs have an important role to play in education and public activism in drowning prevention.

Conflict of interest: none declared.

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