

IRISH ASSOCIATION FOR
**EMERGENCY
MEDICINE**



IAEM Clinical Guideline

Management of Drowning in Children

Version 1

December 2020

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DISCLAIMER

IAEM recognises that patients, their situations, Emergency Departments and staff all vary. These guidelines cannot cover all clinical scenarios. The ultimate responsibility for the interpretation and application of these guidelines, the use of current information and a patient's overall care and wellbeing resides with the treating clinician.

GLOSSARY OF TERMS

°C	Degrees Celsius
APLS	Advanced Paediatric Life Support
ATLS	Advanced Trauma Life Support
ECMO	Extracorporeal Membrane Oxygenation
ED	Emergency Department
ICTS	Irish Children's Triage System
PICU	Paediatric Intensive Care Unit
VF	Ventricular Fibrillation
VT	Ventricular Tachycardia

Management of Drowning in Children

INTRODUCTION

The definition of drowning has changed over recent decades. The most current and widely accepted definition was agreed by the WHO in 2005 and defines drowning as “the process of experiencing respiratory impairment from submersion or immersion in liquid”. Other terms such as ‘near-drowning’ are considered obsolete in this newer definition which encompasses all drowning events and categorises outcomes as either fatal, non-fatal with morbidity or non-fatal without morbidity.¹

The broad spectrum of presentations to the ED following a drowning event pose a particular challenge in risk stratification, particularly in children who are initially well or have minor symptoms.

Fortunately, drowning in children is a relatively uncommon presentation to EDs in Ireland. In 2018, there were 68 accidental drowning related deaths in Ireland, just 3 of which were in those aged 0-19 years. Between 2008 and 2018, 30 children under the age of 14 years died as a result of drowning in Ireland.²

PARAMETERS

<u>Target audience</u>	Health-care professionals working in an ED in Ireland which receives paediatric patients.
<u>Patient population</u>	Paediatric patients presenting to the ED following a drowning event.
<u>Exclusion criteria</u>	Children who have drowned where resuscitation was ceased in the pre-hospital setting.
<u>Contraindications</u>	Nil specific.
<u>Relative Contraindications</u>	Caution should be observed in children with known, serious underlying cardiac, respiratory or neurological conditions as they may require unique adaptations to their care.

AIMS

The aim of this guideline is to assist clinicians in the initial assessment, resuscitation and definitive care of paediatric patients presenting to the ED following a drowning event. Given that this is a relatively rare occurrence, this guideline aims to provide clarification regarding necessary investigations and interventions, the required periods of observation and ultimate disposition of these patients.

ASSESSMENT

Children who do not present in cardiorespiratory arrest should be rapidly assessed with emphasis placed on detection of cardiovascular instability, respiratory distress, hypothermia or altered level of consciousness.³

INVESTIGATIONS

Children who are asymptomatic and alert do not require any investigation. Further investigation should be guided by the child's presenting state.

Pulse oximetry/ arterial blood gas	Pulse oximetry is vital in determining drowning severity and need for treatment. Arterial blood gases may be necessary in hypothermia if a pulse oximetry trace is poor and there is a suspicion of true hypoxia.
Chest x-ray	In well-appearing children with normal vital signs and a normal examination, a chest x-ray is not routinely indicated. ⁴ Parenchymal abnormalities usually predict respiratory decompensation and need for mechanical ventilation.
ECG	May be helpful to diagnose arrhythmias and Long QT syndrome. Also consider ECG changes in hypothermia and continuous cardiac monitoring during rewarming due to the risk of arrhythmia.
CT brain	To rule out traumatic brain injury or other intracranial pathology.
Cervical spine CT	Incidence of cervical spine injury is low in drowning patients. Recommended if there is history of trauma or in the case of drowning with diving.
Blood tests	Indicated in some patients to rule out electrolyte abnormality, hypoglycaemia, coagulopathy, cardiac arrhythmias and co-existing medical condition.

Serum alcohol or toxicological screen	May help determine the cause of drowning
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In patients with significant hypothermia (<32 °C), there should be consideration of cardiac arrhythmia, coagulopathy, deranged electrolytes and rhabdomyolysis as a result of shivering.

MANAGEMENT OF DROWNING

All children who present should be given the appropriate triage category as per ICTS.

Asymptomatic children

In children who are asymptomatic at presentation an 8 hour period of observation, from the time of the event is favoured.^{5,6,7} It is worth noting that if they are to become symptomatic, most children will develop symptoms within the first hour following a drowning incident.⁸

Symptomatic Children

All symptomatic children should have a primary survey performed as per APLS/ATLS protocols and action taken as issues are identified.

Associated Injuries

Overall, trauma associated with drowning occurs infrequently, however a focused clinical exam to assess for traumatic injuries should form part of the secondary survey. Injuries to the cervical spine have been observed to be the most common traumatic injury associated with drowning. As such, immobilisation should be considered until injury is ruled out either clinically

or radiographically, particularly if the history is suggestive of concomitant trauma e.g. a diving related incident.⁹

Antibiotics and Tetanus Prophylaxis

Prophylactic antibiotics have not been shown to be beneficial to victims of drowning.³

The evidence for routine tetanus prophylaxis is poor. Unless there is a wound that may be heavily contaminated, routine tetanus prophylaxis is not indicated following a drowning incident.¹⁰

Management of Hypothermia

Hypothermia occurs commonly with drowning and should be effectively managed to prevent adverse effects such as ventricular arrhythmias.^{5,6}

Hypothermia can be classified as mild, moderate, or severe based on the child's core temperature.

- Mild – 32 to 35°C
- Moderate – 28 to 32°C
- Severe – <28°C

During resuscitation, the temperature should be raised rapidly to 30°C and then at a rate of 0.25 – 0.5°C per hour thereafter in keeping with APLS guidance.⁶

- **All children** with hypothermia should have active and passive external rewarming measures in place, i.e. removal of wet clothing, increasing room temperature, use of heat lamps, heat packs or Bair huggers.
- Children who have **moderate hypothermia** as defined above, should have continuous monitoring during rewarming as cold, acidotic blood in the peripheries returning to the

central circulation can cause a reduction in temperature and pH as well as hypotension due to peripheral vasodilatation.

- In **moderate to severely hypothermic** patients, active internal rewarming measures may be necessary.

Simple initial techniques include administering warmed IV fluids and ventilation with warmed gases where possible.

The temperature of warmed IV fluids and ventilated gases may vary between departments depending on devices used however APLS guidance recommends IV fluids to be warmed to 39 °C and gases to 42 °C.

Other more invasive techniques include lavage of the bladder, stomach, pleura or peritoneum and should only be commenced under consultant guidance.

Cardiorespiratory Arrest Following Drowning

Children in cardiorespiratory arrest following drowning present a unique challenge and the standard protocol for management of cardiac arrest may need to be amended.¹¹ (See below)

In the normothermic patient, manage the arrest as per standard APLS protocols depending on initial rhythm-non shockable PEA/Asystole or shockable-VF/pulseless VT.

In the hypothermic patient the notable changes to the standard APLS algorithms are:

- **Defibrillation** – Below 30°C, limit defibrillation to only 3 shocks until core temperature is above 30°C.
- **Medication** – Do not administer adrenaline or amiodarone if core temperature is below 30°C. When core temperature is between 30 and 34°C, the time interval between administration of medications is doubled.

Indications for PICU Referral

PICU referral should be considered where an ongoing requirement for airway management and/or cardiorespiratory support is anticipated and where neuroprotection and invasive temperature management is necessary.

When to Cease Resuscitation

Ultimately, the decision to cease resuscitation or to escalate care is unique to each case and should be made by the consultant in charge of the resuscitation.

It is worth noting that hypothermia in the setting of drowning in temperate climates has not been shown to have a neuroprotective effect and should not be used as a predictor of survival or an intact neurological outcome in these patients.¹²

ECMO can be discussed on a case to case basis with the PICU team however it is worth noting that prolonged resuscitation/ECMO is likely to carry a poor outcome if the factors below exist.^{13,14,15,16}

- Asystole as the presenting cardiac rhythm
- Submersion time greater than 10 minutes
- Severe hyperkalaemia

SPECIAL CONSIDERATIONS

In all patient groups, consideration of any ongoing safety concerns and referral to the Medical Social Worker on duty should be sent as necessary.

Thought should also be given to potential underlying causes of drowning in children, e.g. seizure, arrhythmia, non-accidental injury or ingestion of toxins, particularly alcohol.

COMPANION DOCUMENTS

- [References](#)