

Drowning - Emergency management in children

Purpose

This document provides clinical guidance for all staff involved in the care and management of a child presenting to an Emergency Department (ED) in Queensland following a drowning event.

This guideline has been developed by senior ED clinicians and Paediatricians across Queensland, with input from PICU, Infectious Diseases and Pharmacy, Queensland Children's Hospital, Brisbane. It has been endorsed for statewide use by the Queensland Emergency Care of Children Working Group in partnership with the Queensland Emergency Department Strategic Advisory Panel and the Healthcare Improvement Unit, Clinical Excellence Queensland.

Key points

- Children should be observed for four to eight hours following a drowning event, even if asymptomatic.
- Hypothermia is common post drowning and should be corrected during resuscitation by removing wet clothes and applying warm blankets. In Queensland active warming measures are rarely needed.
- Consider possibility of an underlying condition (such as epilepsy, cardiac dysrhythmias and hypoglycaemia).
- Consider non-accidental injury (NAI) or neglect in a child presenting with incongruent histories, an obvious lapse in supervision, a delay in seeking care for submersion or other injuries suggestive of NAI (bruises, old fractures).
- Cervical spine immobilisation is not recommended in the absence of head or neck trauma.
- Corticosteroids are not recommended and are potentially harmful.
- Prophylactic antibiotics are not routinely recommended.

Introduction

Drowning is defined by the World Health Organisation as a process resulting in primary respiratory impairment from submersion/immersion in a liquid medium.

Following a drowning event, the child may:

- be asymptomatic
- have some respiratory compromise
- be apnoeic or in cardiac arrest



Drowning injuries may be:

- fatal (any death related to drowning)
- non-fatal (victims who survive drowning with or without morbidity)

In Queensland, the ratio of non-fatal to fatal drowning is 10:1 with approximately two thirds of the non-fatal group admitted to hospital.¹

Hypoxia can cause irreversible neurological injury within 4-10 minutes. Most late deaths and long-term sequelae are neurological.

Epidemiology

The following factors increase the risk of drowning:

- epilepsy – (4-14 fold increase, more likely to be older (more than five years) compared with drownings in children without epilepsy)
- cardiac dysrhythmias - congenital long QT syndrome, catecholaminergic polymorphic ventricular tachycardia and Brugada syndrome may be triggered by swimming
- hypoglycaemia - due to known underlying conditions like diabetes or new metabolic disorders
- hyperventilation – causes hypocapnia which reduces the respiratory stimulus to breathe and can lead to syncope underwater
- hypothermia resulting in body temperature less than 35°C – can cause poor muscle coordination and weakness which interferes with swimming and self-rescue attempts. Rare in Queensland as usually in children who fall through ice
- alcohol and illicit drugs – should be considered in adolescents

Pathophysiology

Drowning usually occurs in seconds to minutes with the following sequence of events:	
	Initial struggle for 20-30 seconds (unable to call for help as breathing takes priority).
	Submersion (airway below the surface of water, water spat out or swallowed).
	Voluntary breath holding (60 seconds maximum).
	Small amount of water aspirated triggering cough reflex and laryngospasm. Respiratory impairment leads to hypoxia, hypercarbia and acidosis.
	Arterial oxygen tension decreases, laryngospasm abates and more water is aspirated.
	Cerebral hypoxaemia leads to loss of consciousness and apnoea.
	Cardiac deterioration with bradycardia and hypotension secondary to hypoxia lead to a cardiac arrest.



Outcome and predictors of outcome

The strongest predictors for outcome are submersion time and CPR duration.

Predictor	Duration	Outcome
Submersion time	Less than 5 mins	91% chance of mild or no neurological impairment
	5-25 mins	90% risk of death or poor outcome
	More than 25 mins	100% risk of severe neurologic impairment or death
Resuscitation	Less than or equal to 10 mins	87% chance of mild or no neurological impairment
	11-25 mins	68% risk of death or poor outcome
	More than 25 mins	100% risk of severe neurologic impairment or death

Based on studies conducted at University of Washington.²

A study in Southern California³⁻⁵ found a poor outcome was likely for a child with any of the following:

- CPR in ED
- apnoea and coma in the ED
- pH less than 7.0

Assessment



ALERT – A drowning event may occur as a result of an underlying medical condition including epilepsy, cardiac dysrhythmias, hypoglycaemia.

Clinical assessment (history and examination) should occur concurrently with patient management (paying particular attention to the optimisation of respiratory function).²

History

History taking should include:

- details of the drowning event including:
 - circumstances leading to the drowning
 - duration of immersion
 - resuscitation (length of CPR and administration of drugs)
- past medical history including:
 - epilepsy
 - personal and family history of cardiac dysrhythmias
 - hypoglycaemia
 - drug and alcohol use

Depending on the circumstances and severity, it may be appropriate to have a social worker with the caregivers, especially in the case of a cardiac arrest or in a post-arrest situation. Child protection issues should also be considered depending on the scenario.²

Examination

Emergency care should always involve a rapid primary survey with evaluation of (and immediate management of concerns with) airway, breathing, circulation and disability (ABCD).



Complete a secondary survey to assess for other injuries and signs of non-accidental injury.

Measure core temperature with a rectal thermometer. Limit hypothermia by avoiding prolonged exposure.

Hypothermia and Acute Respiratory Distress Syndrome (ARDS) are common after a significant drowning event.

Investigations

Investigations for the management of child following drowning event	
Investigation type	Utility
Venous/arterial blood gas analysis	Consider depending on clinical presentation.
CXR	Consider depending on clinical presentation.
ECG	Recommended if suspect cardiac dysrhythmias.
Head CT imaging	Not recommended for non-intubated, conscious child. Consider in child who is intubated and ventilated +/- cardiac arrest. Recommended for any child with a history suspicious of traumatic brain injury/intracranial bleed.
Testing of potassium, renal and haematologic function	Recommended in child with significant hypoxic event or hypothermia.
Coagulation studies and creatinine kinase	Recommended in severely hypothermic or critically-ill child.
Sputum culture	Recommended in intubated patients who have drowned in fresh or brackish water or mud.
Electrolyte and haematocrit levels	Not routinely recommended as rarely abnormal regardless of water in which drowning occurred (freshwater or saltwater).



Seek senior emergency/paediatric advice as per local practice if unsure of need for head CT.

Management

Refer to Appendix 1 for a summary of the emergency management of a child following a drowning event.

Airway and breathing

Management of airway and breathing following a drowning event	
Mild to moderate respiratory compromise	Severe respiratory compromise/ apnoeic
<ul style="list-style-type: none"> Oxygen therapy by mask or nasal prongs to maintain SpO₂ more than 90% (ideally 95%) with an FiO₂ of 0.5. If adequate conscious state (GCS 13-15) and unable to maintain SpO₂ with oxygen therapy consider non-invasive ventilation (HFNC therapy, CPAP or BiPAP). 	<ul style="list-style-type: none"> Tracheal intubation (preferably with a cuffed tube) using a rapid sequence induction technique. Intubated patients require mechanical ventilation with lung protective measures and positive end- expiratory pressure.





Contact paediatric critical care specialist (onsite or via Retrieval Services Queensland (RSQ)) for a child who is post cardiac arrest or critically unwell.

Ventilation with lung protective measures reduces barotrauma and should aim for normocapnia or mild hypocapnia. FiO₂ should be reduced to less than 0.5 as soon as possible to avoid pulmonary oxygen toxicity.

There is no evidence to support the use of corticosteroids.



ALERT – Children who initially appear well following a drowning event may experience clinical deterioration due to pulmonary oedema. All children should be observed for a minimum of four to eight hours to ensure no deterioration prior to considering discharge.

Cervical spine protection

Immobilisation of the cervical spine is not routinely recommended as the risk of a spinal injury occurring with drowning event is low (estimated at less than 0.5%).^{2,6}

Refer to the [Cervical spine Guideline](#) for a child with head and/or neck trauma.

Circulation

Fluid resuscitation using crystalloid solution (e.g. 0.9% Sodium chloride 20 mL/kg) via either IV or Intraosseous (IO) access is recommended for the critically unwell child.

Cardiac dysfunction with decreased cardiac output and high systemic and pulmonary vascular resistance may occur secondary to hypoxia associated with drowning. If this persists after adequate oxygenation, ventilation and perfusion have been re-established seek paediatric critical care advice. Inotropic agents may be required.

Disability

While little can be done to change the neurological damage caused by the primary hypoxic event, secondary injury can be avoided by the prevention of hypoxia, hypercapnia and hyperthermia and maintenance of normoglycaemia.

Seizures following hypoxic brain injury are common. Referral to neurologist for evaluation of seizures will usually occur following transfer to critical care service. There is no evidence for prophylactic anticonvulsant medications.²

Gastrointestinal and genitourinary

Nasogastric tube insertion is recommended in any child with a decreased level of consciousness to prevent aspiration due to vomiting.

Urinary catheter insertion is recommended in a critically unwell child to measure urine output and facilitate a strict fluid balance.

Hypothermia

Remove wet clothes and apply warm blankets to prevent further drop in core temperature.



ALERT – Active rewarming is not routinely recommended as may lead to rapid overshoot of core temperature. Most children will increase their core temperature slowly if further exposure to cold is avoided (by removing wet clothes and applying warm blankets).



A RCT found targeted hypothermia (33°C) did not improve survival or functional outcomes at 12 months when compared to normothermia (36.8°C).⁷ Active rewarming with heating blankets, warm air blowers and radiant lamps should only be considered for patients with a core temperature less than 33-34°C or in rare instances in which hypothermia has led to arrhythmias/haemodynamic instability.



Contact paediatric critical care specialist (onsite or via RSQ) for a child with a core temperature less than 33-34°C.

Core rewarming measures that may be used in ED include warm IV fluids to 39°C and warm ventilator gases to 42°C.

Other measures which require specialist input from critical care include gastric/bladder lavage with 0.9% Sodium chloride to 42°C, pleural or pericardial lavage, endovascular warming and extracorporeal blood re-warming.⁸

Infection

Prophylactic antibiotics are not routinely recommended.

Antibiotics have not been shown to improve outcome and should be restricted to patients demonstrating signs of infection or sepsis, or in the rare patient who was submerged in grossly contaminated water.

Prophylactic antibiotic dosing for children following a drowning event in grossly contaminated water

IV	Ciprofloxacin 10 mg/kg/dose (maximum 400 mg/dose) every eight hours and seek Infectious Diseases specialist advice within 24 hours
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For the guidance on the management of water-related wound infections [click here](#).

Mandatory notification

In Queensland, most fatal paediatric immersion events involve young children gaining unintended access to home/ domestic swimming pools. Domestic pool fencing legislation has been in place since 1991 and was recently strengthened with a requirement for pool fence inspections. Under the Building Act 1975 doctors are required to notify QH of any presentations involving immersion of a child under five years in a “regulated” pool (home, shared unit complex or resort pool). The notification form can be accessed [here](#). Reporting will trigger a local council inspection of the fence regardless of the method of access. It is important to let the family know that this will occur. The most important information to report is the address of the pool.



Escalation and advice outside of ED

Clinicians can contact the services below if escalation of care outside of senior clinicians within the ED is needed, as per local practices. Transfer is recommended if the child requires a higher level of care.



Child is critically unwell or rapidly deteriorating

Includes the following children (as a guide):

- cardiac arrest or ROSC post cardiac arrest
- core temperature less than 33 to 34°C
- need for airway management including intubation
- physiological triggers based on age (see below)

< 2 weeks	< 1 year	1 – 8 years	Over 12 years
<ul style="list-style-type: none"> • RR < 40 or > 60/min • SpO2 < 95% in room air • BP systolic N/A • HR < 100 or > 170 • GCS ALOC 	<ul style="list-style-type: none"> • RR < 20 or > 50/min • SpO2 < 95% in room air • BP systolic < 60mmhg • HR < 90 or > 170 • GCS ALOC 	<ul style="list-style-type: none"> • RR < 20 or > 35/min • SpO2 < 95% in room air • BP systolic < 70mmhg • HR < 75 or > 130 • GCS ALOC 	<ul style="list-style-type: none"> • RR < 15 or > 25/min • SpO2 < 95% in room air • BP systolic < 80mmhg • HR < 65 or > 130 • GCS ALOC

Reason for contact	Who to contact
For immediate onsite assistance including airway management	The most senior resources available onsite at the time as per local practices. Options may include: <ul style="list-style-type: none"> • paediatric critical care • critical care • anaesthetics • paediatrics • Senior Medical Officer (or similar)
Paediatric critical care advice and assistance	Onsite or via Retrieval Services Queensland (RSQ). If no onsite paediatric critical care service contact RSQ on 1300 799 127 : <ul style="list-style-type: none"> • for access to paediatric critical care telephone advice • to coordinate the retrieval of a critically unwell child RSQ (access via QH intranet) Notify early of child potentially requiring transfer. Consider early involvement of local paediatric/critical care service. In the event of retrieval, inform your local paediatric service.





Non-critical child

May include child with:

- respiratory symptoms following a drowning event
- other significant clinical concern

Reason for contact	Who to contact
Advice (including management, disposition or follow-up)	Follow local practice. Options: <ul style="list-style-type: none"> • onsite/local paediatric service • Queensland Children's Hospital experts via Children's Advice and Transport Coordination Hub (CATCH) on 13 CATCH (13 22 82) (24-hour service) • local and regional paediatric videoconference support via Telehealth Emergency Management Support Unit TEMSU (access via QH intranet) on 1800 11 44 14 (24-hour service)
Referral	First point of call is the onsite/local paediatric service

Inter-hospital transfers

Do I need a critical transfer?	<ul style="list-style-type: none"> • discuss with onsite/local paediatric service • view Queensland Paediatric Transport Triage Tool
Request a non-critical inter-hospital transfer	<ul style="list-style-type: none"> • contact onsite/local paediatric service • contact RSQ on 1300 799 127 for aeromedical transfers • contact Children's Advice and Transport Coordination Hub (CATCH) on 13 CATCH (13 22 82) for transfers to Queensland Children's Hospital
Non-critical transfer forms	<ul style="list-style-type: none"> • QH Inter-hospital transfer request form (access via QH intranet) • aeromedical stepdown (access via QH intranet) • commercial aeromedical transfers: <ul style="list-style-type: none"> ○ Qantas ○ Virgin ○ Jetstar

When to consider discharge from ED

Children who are asymptomatic or mildly symptomatic should be observed for a minimum period of four to eight hours to ensure no clinical deterioration (secondary drowning). Admission to a SSU (where relevant) for further observation may be considered. Discharge may be considered providing there is no clinical deterioration in this time.

Follow-up

- with GP within 48 hours.



When to consider admission

Unless only mildly symptomatic, all children should be admitted to an inpatient service or SSU (where relevant). Moderate to severely symptomatic children should be stabilised in the ED and transferred to critical care or inpatient service as appropriate.

Related documents

- [Cervical spine Guideline](#)

References

1. Wallis B et al. Drowning mortality and morbidity rates in children and adolescents 0-19 yrs: a population-based study in Queensland, Australia. *PLoS One* 2015 Feb 25; 10(2): e0117948
2. Semple-Hess J, Campwala R. Pediatric Submersion Injuries: Emergency Care and Resuscitation. *Pediatric Emergency Medicine Practice*. June 2014. Vol 11 No 6.
3. Christensen DW, Jansen P, Perkin RM. Outcome and acute care hospital costs after warm water near drowning in children. *Pediatrics*. 1997;99(5):715-721
4. Kieboom JK, Verkade HJ, Burgerhof JG, Bierens JJ, Van Rheenen PF, Kneyber MC, Albers MJ. Outcome after resuscitation beyond 30 minutes in drowned children with cardiac arrest and hypothermia: Dutch nationwide retrospective cohort study. *BMJ* 2015; 350 doi: 10.1136/bmj.g1284
5. Schilling & Bortolin. Drowning. *Minerva Anestesiologica*. Jan 2012 Vol 78-No 1.
6. Watson RS, Cummings P, Quan L, et al. Cervical spine injuries among submersion victims. *J Trauma*. 2001;51(4):658-662.
7. Moller et al. Therapeutic Hypothermia after Out-of-Hospital Cardiac Arrest in Children. *The New England Journal of Medicine*. May 2015 372(20):1898-1908.
8. Pearn J, Bart R, Yamaoka R. Drowning risks to epileptic children: a study from Hawaii. *Br Med J*. 1978;2(6147):1284-

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Disclaimer

This guideline is intended as a guide and provided for information purposes only. The information has been prepared using a multidisciplinary approach with reference to the best information and evidence available at the time of preparation. No assurance is given that the information is entirely complete, current, or accurate in every respect. We recommend hospitals follow their usual practice for endorsement locally including presenting it to their local Medicines Advisory Committee (or equivalent) prior to use.

The guideline is not a substitute for clinical judgement, knowledge and expertise, or medical advice. Variation from the guideline, taking into account individual circumstances may be appropriate.

This guideline does not address all elements of standard practice and accepts that individual clinicians are responsible for:

- Providing care within the context of locally available resources, expertise, and scope of practice
- Supporting consumer rights and informed decision making in partnership with healthcare practitioners including the right to decline intervention or ongoing management
- Advising consumers of their choices in an environment that is culturally appropriate and which enables comfortable and confidential discussion. This includes the use of interpreter services where necessary
- Ensuring informed consent is obtained prior to delivering care
- Meeting all legislative requirements and professional standards
- Applying standard precautions, and additional precautions as necessary, when delivering care
- Documenting all care in accordance with mandatory and local requirements

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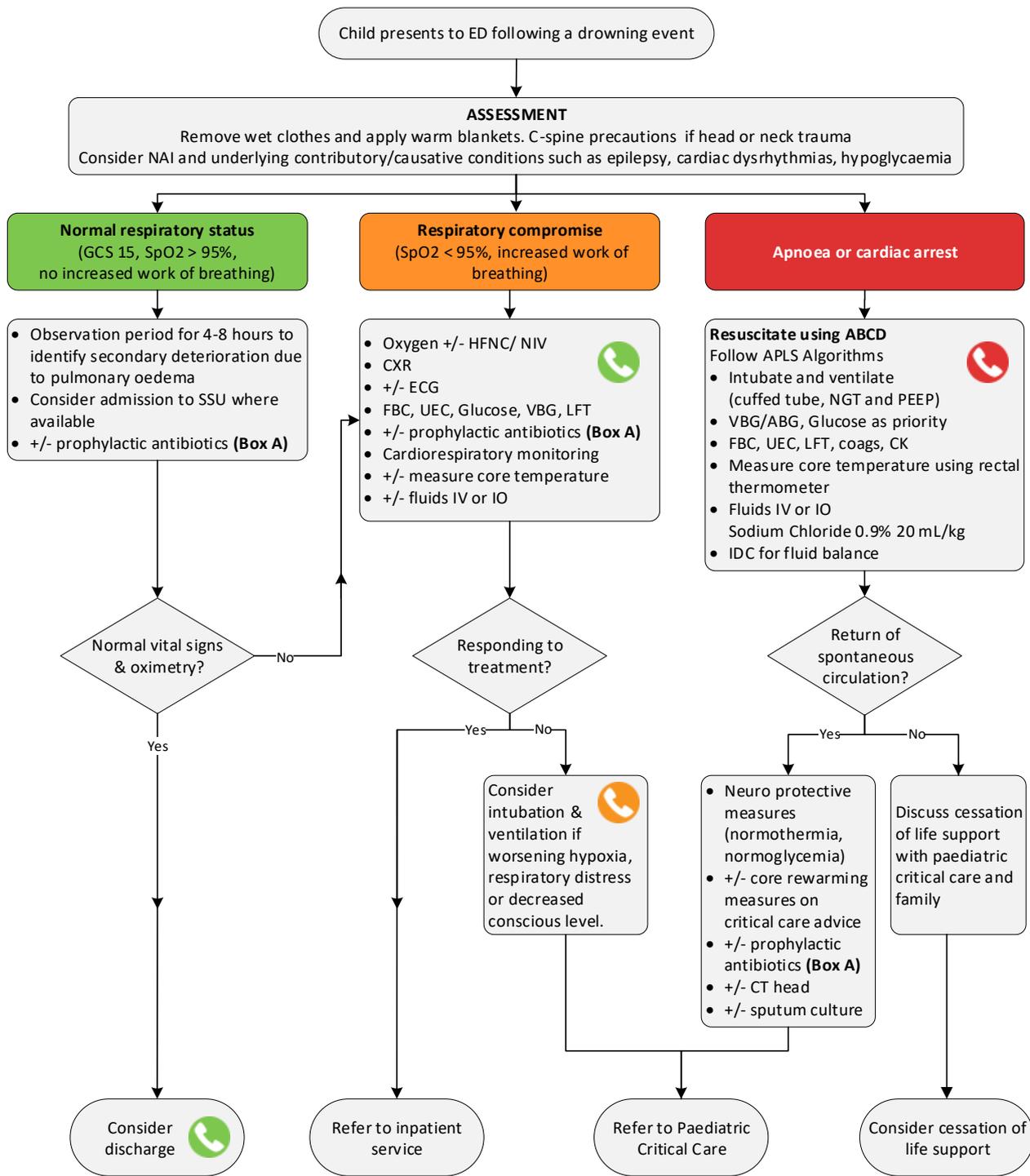


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Box A: Prophylactic antibiotic dosing

Following a drowning event in grossly contaminated water administer Ciprofloxacin 10 mg/kg/dose IV (Max 400 mg/dose) every 8 hours and seek Infectious Diseases specialist advice within 24 hours.

Prophylactic antibiotics are not recommended following submersions in other water types.

Consider seeking senior emergency/ paediatric advice as per local practices

Seek senior emergency/ paediatric advice as per local practices

Seek urgent paediatric critical care advice (onsite or via Retrieval Services Queensland (RSQ) on 1300 799 127)

