Drowning

Definition / Supporting Information

This KPP refers throughout to Advanced Paediatric Life Support (APLS): The Practical Approach (5th edition) and European Paediatric Life Support (EPLS) for use in the UK (3rd edition), both of which may not have national accreditation for guidance development

Drowning is a process resulting in primary respiratory impairment from submersion / immersion in a liquid medium.

The term 'near drowning' and 'wet' or 'dry' drowning are no longer official terms mainly because they have been used differently worldwide, which has caused confusion.

Starting resuscitation at the scene is vital to the outcome from drowning.

- Basic life support (BLS) should be started as quickly as possible (70% survival)

Prognostic indicators in drowning:

- Immersion time
  - Most children immersed for more than 10 minutes have a very small chance of intact neurological recovery or survival
- Indicators of poor prognosis
  - Delay of more than 10 minutes before start of BLS
  - Absence of response within 40 minutes (unless respiration has been depressed by hypothermia, medication or alcohol)
  - Persistent coma (GCS score < 5)
  - Persistent acidosis (pH < 7.1)
  - Arterial blood pO2 < 8 despite treatment
- Indicators of good prognosis
  - First respiratory effort within 3 minutes after start of BLS
  - Core temperature of < 33°C on arrival, and a water temperature of < 10°C
    - This effect is greater in small children due to the large surface area to weight ratio

Essential History

Ascertain the facts after resuscitation has been started or while it is ongoing.

Ask about:

- Sources of information
  - Witness

  - Bystander
  - Rescuer
  - Health care provider
- Age of child
- Type of water
  - Freshwater versus seawater is not an important predictor of prognosis
  - Contaminated water may be associated with unusual organisms
- Location of water
  - Open water– lake, pond
  - Swimming pool
  - Bath
- Temperature of water
- Duration of submersion
- Initial resuscitation attempts, for how long and by whom
- Circumstances including:
  - Level of supervision (especially younger children)
  - Use of drugs and / or alcohol (older children)
  - History of diving (potential for neck injury)
  - Possibility of associated injury
  - Any safeguarding concerns
- Pre-existing medical conditions
  - Epilepsy
  - Cardiac history
  - Psychiatric history (potential for self harm)

‘Red Flag’ Symptoms and Signs

Ask about:

- Duration of submersion
  - Most children immersed for more than 10 minutes have a very small chance of intact neurological recovery or survival
- Temperature of water
  - A water temperature of more than 10°C has been associated with increased survival
- Risk factors for associated injuries (particularly spinal)
- Time to start of BLS
  - Delay of more than 10 minutes before start of BLS is associated with a poor prognosis

- Response to BLS
  - Absence of response within 40 minutes (unless respiration has been depressed by hypothermia, medication or alcohol) is associated with a poor prognosis
- Persistent coma (GCS score < 5)

Look for:

- Associated injuries
- Pre-existing conditions (eg, Medic Alert)

Differential Diagnosis / Conditions

Consequences / associations of drowning include:

- Hypothermia
  - Commonly associated with submersion injuries
  - May protect against neurological sequelae
  - Can also lead to complications including:
    - Arrhythmias
    - Coagulation disorders
    - Susceptibility to infections
- Cervical spine injuries
  - Should always be suspected
  - More common in drowning associated with diving and road traffic accidents
  - Rare in children under 5 years of age
  - Prevalence 0.5% overall
- Alcohol or drug intoxication (see Drug Overdose and Posioning)
- Mental health issues and possible suicide attempt
- Neglect or lack of simple safety measures in a young child

Investigations

(see also Treatment Approach)

- Imaging studies may be required to make certain that internal organs are not adversely affected
  - Chest x-ray
  - Cervical spine x-ray
  - Computerised tomography (CT) scan of head and neck once the child is stable
  - Ultrasound to look at abdominal organs
- Laboratory testing may include:
  - Blood glucose

  - Blood gas analysis and blood lactate
  - Urea and electrolytes
  - Coagulation studies
  - Blood and sputum cultures
- Electrocardiogram (look for prolonged QT syndrome)

Treatment Approach

Initial rescue

- Effective Cardiopulmonary Resuscitation (CPR) at the scene is a major determinant of success
- All first responders should be trained in Basic Life Support (see Chapter 3, European Paediatric Life Support Manual [Resuscitation Council])

Priorities of resuscitation:

- Correction of hypoxia
- Correction of hypothermia
- Treatment of life-threatening associated injuries
- Treatment of non-life-threatening injuries

Emergency response

- At the scene, the aim of resuscitation attempts is to restore:
  - Cardiac output
  - Tissue oxygenation
  - Acid-base status

Critical steps:

- Airway
  - Assess patency of the airway
  - Clear airway of any debris before attempting to ventilate the patient
- Breathing
  - Attempt to ventilate the patient with:
    - A bag-mask device
    - Intubation
- Try to protect airway from aspiration of stomach contents
  - Place a nasogastric tube
- Try to protect lungs from aggressive positive pressure ventilation, which may produce:
  - Overdistension of lungs
  - Barotrauma

- Circulation
  - CPR as required
- The child should be transferred to closest emergency department (ED) that deals with children.

Stabilisation

- In the Emergency Department (ED):
  - Continue CPR if required
    - See resuscitation guidelines covered in the Advanced Paediatric Life Support Manual [Advanced Life Support Group] and European Paediatric Life Support Manual [Resuscitation Council]
  - Further stabilisation should aim to provide:
    - Appropriate respiratory support
    - Management of arrhythmias
    - Vascular access and management of shock
    - Gastric decompression (nasogastric tube) as swallowed water can lead to risk of aspiration
    - Bladder catheterisation to monitor fluid balance
- Management of hypothermia should proceed as per Advanced Paediatric Life Support (APLS) guidance

Rewarming strategies

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External rewarming

- Remove cold, wet clothing
- Supply warm blankets
- Warm air system
- Heating blanket
- Infrared radiant lamp

Core rewarming

- Warm intravenous fluids to 39°C to prevent further heat loss
- Warm ventilator gases to 42°C to prevent further heat loss
- Gastric or bladder lavage with normal (physiological) saline at 42°C
- Peritoneal lavage with potassium-free dialysate at 42°C, 20ml/kg with a 15 minute cycle
- Pleural or pericardial lavage
- Endovascular warming

- Extracorporeal blood rewarming
- Active rewarming should be employed if the temperature is under 30°C
  - Arrhythmias are refractory to defibrillation if core temperature is under 30°C
- Resuscitation should be continued until the core temperature is at least 32°C
- The child's cardiorespiratory status should be monitored, including:
  - Continuous electrocardiographic monitoring
  - Recording of oxygen saturation
  - Blood pressure and pulse

In the child who is spontaneously moving and breathing:

- Close observation and monitoring are required to ensure that response to the submersion injury is not delayed
  - Respiratory deterioration can occur 4-6 hours after submersion

Secondary survey

- Examine carefully for any injuries
- Be aware that there may be alcohol and / or drug ingestion
- Imaging studies may be required to make certain that internal organs are not adversely affected
  - Chest x-ray
  - Cervical spine x-ray
  - Computerised tomography (CT) scan of head and neck once the child is stable
  - Ultrasound to look at abdominal organs
- Laboratory testing may include:
  - Blood glucose
  - Blood gas analysis and blood lactate
  - Urea and electrolytes
  - Coagulation studies
  - Blood and sputum cultures
- Electrocardiogram (look for prolonged QT syndrome)
- Patients should be assessed to exclude pneumothorax or other evidence of air leak
- Prophylactic antibiotics are not usually indicated unless immersion is in severely contaminated water

When to Refer

- Refer urgently (arrange emergency transport) all patients with drowning to specialist practitioners (eg, Emergency Department (Paediatric if possible) Team) for complete physical, laboratory, and imaging evaluation
- Escalate to high dependency or intensive care, patients with:
  - Significant respiratory distress requiring oxygen

  - Abnormal sensorium
  - Abnormalities on coagulation, liver, and renal function studies
- Transfer children who have required full resuscitation and ventilator or cardiovascular support to a Paediatric Intensive Care Unit
  - Early discussion with the local / regional Paediatric Intensive Care Team is vital to help manage the child and reduce secondary complications

When to Admit

- Admit to hospital children who:
  - Require significant amounts of oxygen
  - Have any abnormal imaging
  - Have an abnormal sensorium
- Escalate to high dependency or intensive care, patients with:
  - Significant respiratory distress requiring oxygen
  - Abnormal sensorium
  - Abnormalities on coagulation, liver, and renal function studies
- Transfer children who have required full resuscitation and ventilator or cardiovascular support to Paediatric Intensive Care Unit
  - Early discussion with the local / regional Paediatric Intensive Care Team is vital to help manage the child and reduce secondary complications.

Principles of management on the Paediatric Intensive Care Unit (for information)

- Management is aimed at:
  - Restoring cardiac output
  - Minimising brain injury
  - Preventing catastrophic complications
- Neurointensive care support is often required
- Aggressive management of increased intracranial pressure
- Management of hypothermia
- Acid base balance, normoglycaemia, and coagulation defects
- Management of sepsis and infection
- Efforts should be made to assess the degree of neurological injury over the first 24–48 hours
  - Electroencephalography may help identify electrical seizures
  - Seizure activity should be treated quickly and aggressively
  - Patients should receive sedation only if clinically indicated
  - Severity of encephalopathy is the main determinant of outcome

‘Safety Netting’ Advice

In the child who is spontaneously moving and breathing:

- Close observation and monitoring are required to ensure that response to the submersion injury is not delayed
  - Respiratory deterioration can occur 4-6 hours after submersion
- Children may be discharged after 8 hours if they have:
  - Acceptable oxygen saturation in room air
  - Age-appropriate responses
  - Normal Glasgow Coma Scale (GCS) score

For any child discharged from the ED after an episode of drowning, carers must be given advice as to when to return (eg, increased work of breathing (see Dyspnoea, fever).

Patient / Carer Information

- Drowning: First aid for a child (Web page), aboutkidshealth
- Bath seats and child drownings (Web page), The Royal Society for the Prevention of Accidents
- Water safety at home (Web page), Safe Kids Worldwide
- Unintentional drowning: Get the facts (Web page), Centres for Disease Control and Prevention
- Drowning and near drowning (Web page), Patient
- Drowning (Web page), Child Accident Prevention Trust
- Baby and toddler safety (web page), the NHS website
- Summer safety for younger children (Web page), the NHS website
- Suicide - Prevention (Web page), the NHS website
- Sudden unexpected death in epilepsy (Web page), Patient
- Safeguarding children (Web page), Patient
- Self-harm and risky behaviour (e-Learning), MindEd
- Managing risk: Self-harm and suicidality (e-Learning), MindEd
- Drugs and alcohol: Information for young people (Web page), Royal College of Psychiatrists
- Alcohol, drugs and addiction (Web page / pdf), Royal College of Psychiatrists
- Self-harm (Web page), Royal College of Psychiatrists

Resources

National Clinical Guidance

Strategies to prevent unintentional injuries among the under-15s (Web page), NICE clinical guideline PH29, National Institute of Health and Care Excellence.

Self-harm: The short term physical and psychological management and secondary prevention of self-harm in primary and secondary care (Web page), NICE clinical guideline CG16, National Institute of Health and Care Excellence.

When to suspect child maltreatment (Web page), NICE clinical guideline CG89, National Institute of Health and Care Excellence.

Depression in children and young people (Web page), NICE quality standard QS48, National Institute of Health and Care Excellence

The epilepsies: The diagnosis and management of the epilepsies in adults and children in primary and secondary care (Web page), NICE clinical guideline CG137, National Institute of Health and Care Excellence.

Paediatric advanced life support (Web page), Resuscitation guidelines 2015, Resuscitation Council UK

Medical Decision Support

Advanced Life Support Group. Advanced Paediatric Life Support: The Practical Approach (APLS), 5th ed. John Wiley & Sons (Wiley-Blackwell), 2011.

Resuscitation Council. European Paediatric Life Support (EPLS) for use in the UK. 3rd ed. 2011.

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