Clinical Guidance

Paediatric Critical Care: Post-resuscitation care after sustained Return of Spontaneous Circulation (ROSC) following Cardiac Arrest

Summary

Guideline for management of children after sustained Return of Spontaneous Circulation (ROSC) following Cardiac Arrest. For use in paediatric critical settings across RBH and Evelina and elsewhere until STRS arrive. This reflects current practice- further neuromonitoring involving continuous EEG, BIS, transcranial doppler, serum neuromarkers may be beneficial and used in other centres.

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Relevant external law, regulation, standards	

Change History		
Date	Change details, since approval	Approved by
	Decision by STRS to advise loading with prophylactic leviracetam is based on lack of availability of EEG.	

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Post-Cardiac Arrest Syndrome and associated clinical features

Myocardial dysfunction: tachycardia, weak pulses, poor perfusion, hypotension, arrythmia, pulmonary oedema- ARDS picture
Hypoxic ischaemic encephalopathy: raised ICP (Cushing's triad), asymmetrical or unresponsive pupils, seizures, myoclonus
Systemic ischemia/ reperfusion injury: Systemic inflammatory response characterised by coagulopathy, hypotension, pyrexia, hypovolemia, hyperglycemia, multi-organ dysfunction

Haemodynamic instability/ recurrent cardiac arrest: consider E-CPR if available

After **sustained ROSC** children are at high-risk for developing Post-Cardiac Arrest Syndrome (PCAS). Post-resuscitation care should start immediately and continue for **72 hours**:

1. **Prevent further cardiac arrest:** Systematic multi-system approach to manage the unstable patient
2. **Neuroprotection** with target parameters to prevent/ minimise secondary brain injury
3. Diagnostic investigations and imaging to diagnose primary cause/ contributing factors

Prevent Further Cardiac Arrest

- Full history and examination to elicit underlying cause
- Definitive management of reversible cause of cardiac arrest
- Early transfer to PICU: consider sub-specialty based on pathology, availability of ECMO

Other Investigations:

CXR +USS: ETT position, pneumothorax, aspiration, large effusion
CT: undertake if potential cause of arrest or ICP concerns
Echo: effusion, function, structural abnormalities, thrombus
12-lead ECG: ST segment changes, arrythmias
Bloods: FBC, coag, renal profile, Mg+, LFT, CK, troponin, G&S

Management

Respiratory

- Aim for adequate ventilation with minimal Ventilator-Induced Lung Injury (VILI)
- Often need to ↑PEEP: pulmonary oedema, poor oxygenation, reduces LV afterload
- SpO_2 94 - 97%, avoiding hyperoxia (CHD/ARDS may reduce target)
- Normal pCO_2 optimise cerebral blood flow

Cardiovascular

- Aim mean arterial pressure ≥50th centile for child's age
- Assess for fluid responsive hypotension: most patients euvolemic unless primary etiology is sepsis
- **Early** use of vasoactive agents to support blood pressure and cardiac function: echo and initial assessment to guide choice- noradrenaline often used
- Trend venous sats, lactate, NIRS to assess O_2 delivery/consumption/shock reversal
- Treat primary life-threatening arrhythmias
- Manage electrolytes (K+, iCa, Mg, PO_4): prevent arrest, lower seizure threshold

Neurology

- Reduce metabolic rate and O_2 consumption
- Use short-acting sedative and opioids to keep well-sedated
- Muscle relaxation: may be needed to treat shivering or control CO_2 **- concern that mask seizures and hinder neurological assessment**
- Use 24-hour EEG or aEEG if available, all require at least one formal EEG
- Prophylactically load with Levetiracetam and continue until EEG assessment
- Monitor cerebral and flank NIRS trends: assess any significant changes
- Monitor **and** treat signs/ symptoms raised ICP with hypertonic saline
- Aim Na+ 145-150mmol/L

Exposure

- **Avoid hyperthermia**: electively use active cooling device, anti-pyretic to maintain normothermia. If hypothermic then rewarm by 1°C every 6 hours to target.
- Monitor urine output as AKI and oedema common. Optimise perfusion of kidneys, consider furosemide/ renal replacement therapy
- Maintain normoglycaemia: ≤10mmol/L- low threshold for insulin infusion
- Enteral feed as early as possible unless concerns of gut ischaemia
- CRP, PCT, viral PCRs, cultures: **lumbar puncture contra-indicated if raised ICP**
- Minimal interventions/ handling
- Consider need for sedation/ analgesia bolus pre-procedure
- Head in neutral midline position at 30° angle
- Avoid neck ties/ collars: impair cerebral venous drainage

Further management/neuro-prognostication involve neurologist

- Confounders to assessment: sedation +/- AKI, paralysis (train of four can be used)
- Prognostic MRI within first 5 days/ as soon as cardiovascularly stable
  - Assess extent of injury, guide prognosis/ treatment decisions
  - Pseudo normalisation occurs > 5days
- Brain-stem testing/ withdrawal of life-sustaining therapy: **early** referral to SNOD and paediatric palliative care
- Manage expectations of family considering culture, religion and wishes

Specific arrest scenarios: E-CPR, Sepsis , Neonatal collapse, Drowning

Continuous monitoring and observations

- O_2saturations, etCO_2, ECG, core body temp
- Intra-arterial blood pressure
- Intra-venous access and CVP
- Cerebral and flank NIRS
- Glasgow coma scale (GCS)
- Pupillary size and response
- Urinary catheter

Neuroprotection targets

- SaO_2 94 - 97%
- Arterial CO_2 4.8-6kPa
- BP ≥50th centile(next page) or >65mmHg
- Na+ 145 - 150mmol/L
- BM 6 - 10mmol/L
- Cool to normothermia (36.0°C– 37.0°C)
- Minimal interventions/ handling
- Head midline and 30° elevated

Raised Intracranial pressure (ICP) associated with high risk of cerebral herniation or 'coning' can develop acutely

Early signs/symptoms:

- Reduced/ fluctuating conscious level
- Bulging fontanelle
- Vomiting
- Seizures

Later signs/symptoms

- Hypertension and bradycardia
- Abnormal breathing pattern
- Pupillary changes
- Posturing (decorticate/ decerebrate)
- Papilloedema
- Cushing's triad (hypertension, bradycardia, altered respiratory pattern)
- Polyuria (evolving diabetes insipidus)

Urgent CT: acute management/ intervention

Outcomes OHCA- of those *admitted* to PICU - 30% survival to PICU discharge

Poor prognostic factors

Cardiac Arrest:

- <1 year of age, OHCA, Unwitnessed, Asystole, No ROSC on arrival to hospital, long resuscitation, >1 dose of adrenaline

Neuro assessment

- Malignant EEG at >24h, myclonus < 72h, Absent SSEPs, Diffuse HIE on imaging
- At ≥72h: absent pupillary/corneal reflexes, GCS M≤3

Ref: Garner, M.M. et al. (2023), *Cril Care*, 27(388). Topijan, A. et al. (2019), *Circ*, 140(6). Nolan, J. et al. (2021), *ICM. Moler FW.(2017)NEJM*

Blood pressure Targets

Current adult guidance advises mean blood pressure target of >65 mmHg with evidence of good perfusion

Download Paediatric Emergency Tools to phone/personal device which provides paediatric systolic and diastolic centiles for blood pressure by age.

There is limited evidence in paediatrics to suggest an ideal blood pressure target.

The table below shows estimated 50th centile mean blood pressure to be targeted if there are concerns of cerebral injury/ raised ICP. 50th centiles are more than the adult target from 7 years of age which is not logical therefore adult target is advised for these ages. These blood pressure targets may be adjusted in some patients e.g patient with cardiomyopathy where cardiac dysfunction would not cope with high SVR/ increasing noradrenaline.

Age	Mean blood pressure 50th centile mmHg
0-5 months	45
6-11 months	50
1-2 years	55
3-4 years	60
5-6 years	65
Would advise adult target of >65mmHg for all children >5y	
7-9 years	70
10-16 years	75

Values > 1year adapted from reference assuming height 50th centile, estimating single value for age bands and merging gender values. Values < 1year consensus opinion.

Haque, Ikram U. MD, FAAP; Zaritsky, Arno L. MD, FAAP, FCCM. Analysis of the evidence for the lower limit of systolic and mean arterial pressure in children. Pediatric Critical Care Medicine 8(2):p 138-144, March 2007.