Paediatric Intensive Care Unit

Post-resuscitation care

Staff relevant to:	Medical and Nursing staff caring for children in the PICU
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Version:	2.0
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Related Guidelines and Policies:	
B1/2012	Safeguarding children policy
C94/2006	Death of a child (age 0-18) in the Emergency Department

1. Introduction

This guidance can be used as an aid and learning tool by medical, nursing and allied health professional staff involved in the post-resuscitation care of paediatric patients within East Midlands Congenital Heart Centre and Leicester Children's Hospital.

Successful return of spontaneous circulation (ROSC) is the first step towards the goal of complete recovery from cardiac arrest. Depending on the cause of the arrest, and the severity of the post-cardiac arrest syndrome, many patients will require multiple organ support and the treatment they receive during this post-resuscitation period influences significantly the overall outcome and particularly the quality of neurological recovery.

POSTRESUSCITATION CARE

A & B	✓ Confirm ET tube position (visualise, auscultate, ETCO2, chest-XR) ✓ Target sats 94-98% (higher only if CO poisoning, methemoglobinaemia, severe anaemia; or usual saturation in cardiac patients) ✓ Waveform capnography; target PaCO2 4.5-5kPa ✓ Pass oro/nasogastric tube to decompress stomach (oral tube if severe coagulopathy or basal skull fracture) ✓ Protective lung ventilation (Vt 6-8ml/kg), PEEP individualised to achieve PaO2/PaCO2 targets and cerebral venous drainage (advantageous isamode with stable minute ventilation like PRVC- check pressure limits!) ✓ Chest physio/suction can cause an increase in ICP; consider an additional bolus of sedation/analgesia before suction/physio	**HYPOXEMIA SHOULD BE STRICTLY AVOIDED** **TOO LOW OR TOO HIGH PaCO2 WORSEN THE OUTCOME** Brief hyperventilation can be used as a rescue therapy if signs of impending herniation (avoid paCO2 <4kPa)
C	✓ Restore normovolaemia (crystaloids in traumatic brain injury) ✓ Gain reliable iv access (preferably central venous line – avoid internal jugular if concerns regarding brain ischaemia or traumatic braininjury) ✓ Inotrope/vasopressor to target BP and adequate tissue perfusion ✓ Invasive arterial blood pressure ✓ Consider 12 lead ECG and ECHO	**HYPOTENSION SHOULD BE STRICTLY AVOIDED** SYSTOLIC BLOODPRESSURE >60mmHg in term neonates >70mmHb in 1-12 months >70 + (2x age in years) (1-10yrs) >90mmHg >10 years of age TBI protocol Mean bloodpressure: 0 – 2 years 60mmHg 2 - 6 years 70mmHg > 6 years 80mmHg
D & E	✓ Monitoring of central temperature is mandatory ✓ Use cooling mattress to control temperature and prevent fever ✓ Maintain temperature at 36dgrC for at least 24h; prevent fever for 3 – 5days ✓ Prevent shivering with adequate sedation +/- paralysis ✓ Keep the head elevated at 30dgr in neutral alignment with the neck (best venous drainage) – supine position ✓ Diagnose and treat seizures aggressively (changes in HR, BP, pupils size and response; EEG, CFAM) ✓ Timing of brain imaging: CT ASAP followed by MRI ideally 3 – 5 days after injury	**FEVER (>37. C)** **5** **SHOULD BE TREATED AGGRESSIVELY** **Check pupils frequently** **If change in response inform PICU Consultant immediately & consider bolus of hypertonic sodium chloride 2.7%**
F	✓ Maintenance at 60% of intake ✓ Maintain normoglycaemia (4 – 12mmol/L) ✓ Monitor Na (>145mmol/L) and osmolarity (<360mOsm/L) ✓ Insert urinary catheter and monitor urine output (Diabetes insipidus suspected if: SG <1005, Na 145mmol/l and rising, UO >4ml/kg/h) ✓ Body map & ophtalmology if NAI suspected; send toxicology	**AVOID FLUID OVERLOAD** **AVOID HYPOGLYCAEMIA (<4mmol/L)**

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2. The post-cardiac arrest syndrome comprises:

- post-cardiac arrest brain injury
- post-cardiac arrest myocardial dysfunction
- systemic ischaemia/reperfusion response
- persistent precipitating pathology

2.1 The goals [1,2]

1. Achieve normoxemia – sats 94-98% (higher only if CO poisoning, severe anaemia, methemoglobinaemia) - while ensuring that hypoxemia is strictly avoided. There is some evidence that normoxemia after ROSC is associated with improved survival while hyperoxemia showed relationship to an increased mortality. In children with known cardiac disease target their usual saturations.

2. In children who do not recover consciousness immediately following ROSC controlled ventilation is recommended. Cerebral autoregulation may be abnormal and as blood pH and PaCO2 level influence cerebral blood flow targeting normal levels (PaCO2 4.5 – 5 kPa) may help prevent further secondary brain injury (cerebral oedema, ischaemia). Intentional brief hyperventilation may be used as a temporizing rescue therapy if there are signs of impending brain herniation (eg. dilation one or both pupils with decreased response to light, bradycardia and hypertension; sudden rise in measured intracranial pressure). Avoid PaCo2 <4kPa.

3. Myocardial dysfunction and vascular instability are common after resuscitation from cardiac arrest. Hypotension (defined as a systolic blood pressure less than 5th percentile for age and height) after ROSC is associated with lower likelihood of survival to discharge with favorable neurological outcome.

4. Fever after paediatric cardiac arrest is common and is associated with poor outcomes. A child who has ROSC and is hypothermic, but remains comatose shouldn't be actively rewarmed unless the core temperature is <32dgrC. The patient may benefit from having their core temperature actively maintained at 36.8dgrC for at least 24h post arrest (cooling mattress is required). Central temperature should be monitored continuously and temperature > 37.5 dgrC has to be treated aggressively. It is reasonable to prevent fever and maintain normothermia 3 – 5 days post arrest. Adequate sedation and pain relief will reduce oxygen consumption and blunt the stress-related surge of endogenous catecholamines. In view of earlier neurological assessment and prognostication short acting drugs could be considered (e.g. remifentanil).

5. Actively look for seizures and control them as they increase metabolic rate of the brain and have the potential to exacerbate brain injury. Routine seizure prophylaxis is not recommended.

6. Hyper/hypoglycaemia is associated with poor outcome. Tight glucose control has not shown survival benefit; it increased risk of hypoglycaemia.

7. Fluid management: 0.9% Sodium chloride +/- 5% glucose at 60% of intake. Maintain serum Na level at the upper level of the range. Commence enteral feeding as soon as possible – review for feeding at 6h post admission. Consider laxatives if sedated > 48 hours.

8. Imaging timing:

    a. CT ASAP to rule out precipitating factors of cardiac arrest or changes requiring an acute intervention.
    b. MRI (using DWI and conventional sequence) ideally 3rd (2nd - 5rd) day for the extend of hypoxic ischaemic injury and prognostication.

9. If at any time emerging information give rise to child protection concerns Safeguarding children policy should be followed.

2.2 Prognosis

No single prognostic factor is sufficiently reliable to inform decisions about termination of a resuscitation attempt or the likely outcome.

Factors that should influence any decision include:

- the circumstances of the arrest,
- initial rhythm,
- duration of resuscitation,
- and other features such as presence of hypothermia and severe metabolic derangement.

Prognostication of the comatose post cardiac arrest patient should be multimodal, and should be delayed sufficiently to enable full clearance of sedatives and any neurological recovery to occur – in most cases, prognostication is not reliable until after 72hours from cardiac arrest. Comatose children with ROSC receiving mechanical ventilation who fulfil neurologic criteria for death, or in whom withdrawal of life sustaining treatment is planned should be considered as **potential organ donors.**

3. Education and Training

Training and raising awareness are on-going processes. On-going awareness is promoted through the induction and continuous bedside teaching. Training is provided for medical staff during lunchtime teaching (Wednesdays) and other sessions, and at junior doctors' induction training. Nursing education is supported by the Practice Development teams, and nursing educators.

4. Monitoring Compliance

What will be measured to monitor compliance	How will compliance be monitored	Monitoring Lead	Frequency	Reporting arrangements
Adherence to the guideline	audit	Julia Vujcikova	As required	CPM/Risk

5. Supporting References

1. eccguideline.heart.org
2. resus.org.uk
3. Huang B, Castillo M. Hypoxic-ischaemic brain injury: Imaging findings from birth to adulthood. Radiographics. 2008;28(92):417-439.
4. Pinto PS, Tekes A, Singhi S, Northington FJ, Parkinson C, Huisman TA. Whitegray matter echogenicity ratio and resistive index: sonographic bedside markers of cerebral hypoxic-ischemic injury/edema?. *J Perinatol*. 2012;32:448-53.
5. Gerner GJ, Burton VJ, Poretti A, Bosemani T, Cristofalo E, Tekes A, et al. Transfontanellar duplex brain ultrasonography resistive indices as a prognostic tool in neonatal hypoxic-ischemic encephalopathy before and after treatment with therapeutic hypothermia. *J Perinatol*. 2016; 36:202-6.

6. Key Words

Post-resuscitation care, ROSC, Neuroprotection, Cardiac arrest, Neuroimaging, Hypoxic-ischaemic injury (HII)

The Trust recognises the diversity of the local community it serves. Our aim therefore is to provide a safe environment free from discrimination and treat all individuals fairly with dignity and appropriately according to their needs.
As part of its development, this policy and its impact on equality have been reviewed and no detriment was identified.

CONTACT AND REVIEW DETAILS	
Guideline Lead (Name and Title) Julia Vujcikova – Consultant	**Executive Lead** **Chief Nurse**
Details of Changes made during review: **Post Resuscitation algorithm Step F-** **Added – Avoid Hypoglycaemia <4mmol/L** **2.1 The goals-** **Added –** **1.** In children with known cardiac disease target their usual saturations. **2.** A child who has ROSC and is hypothermic, but remains comatose shouldn't be actively rewarmed unless the core temperature is <32dgrC. **9.** If at any time emerging information give rise to child protection concerns Safeguarding children policy should be followed.	