ANZCOR Guideline 12.7 – Management after Return of Spontaneous Circulation (ROSC)

Summary

Who does this guideline apply to?

This guideline applies to infants and children.

Who is the audience for this guideline?

This guideline is for health professionals and those who provide healthcare in environments where equipment and drugs are available.

Recommendations

The Australian and New Zealand Resuscitation Committee on Resuscitation (ANZCOR) make the following recommendations:

1. This guideline provides advice regarding post resuscitation care, prognostication, and cessation of CPR.
2. ANZCOR recommends careful attention to maintaining adequate circulation, ventilation, temperature control and normoglycaemia following ROSC.
3. There is limited evidence for specific post ROSC target values for PaO_2 or $PaCO_2$. ANZCOR recommends targeting normal physiological values or values appropriate to the long term condition of the individual child (e.g. cyanotic heart disease or chronic lung disease).
4. ANZCOR recommends avoiding hyperthermia post ROSC. It is acceptable to target normothermia (36-37.5C) or hypothermia (32-34C) in the post ROSC period.
5. ANZCOR recommends that parents/caregivers are supported to be present during resuscitation attempts for their child if they wish to do so.
6. ANZCOR recommends that staff are provided with both psychological support and skills maintenance feedback following resuscitation of infants and children.

1 Continuing Support

Supportive therapy should be provided until there is recovery of function of vital organs. This may include the provision of oxygen therapy, mechanical ventilation, parenteral fluids, inotropic infusion and renal support for several days or longer. Recovery in infants and children is usually slow because cardiorespiratory arrest is often secondary to prolonged global hypoxaemia and ischaemia which implies that other organs sustain damage before cardiorespiratory arrest. Particular care should be taken to ensure adequate cerebral perfusion with well oxygenated blood and blood pressure appropriate for age.

The cause of cardiorespiratory arrest should be sought and treated. Remediable causes include hypoxaemia, hypovolaemia, hypo/hyperthermia, electrolyte disorders including hypo/hyperkalaemia and disorders of calcium and magnesium levels, cardiac tamponade and pneumothorax (requiring relief) and toxins, poisons and drugs (requiring removal or antagonism). A membrane ion channelopathy should be considered in the case of sudden unexpected cardiac arrest.

Complications of CPR should also be sought, especially if secondary deterioration occurs. A chest radiograph should be obtained to check the position of the endotracheal tube, to detect pneumothorax, lung collapse, rib fracture or aspiration and to check if tamponade is suggested by the cardiac silhouette. A blood sample should be obtained for measurement of haemoglobin, pH, gas tensions, electrolytes and glucose. Echocardiography is useful to monitor recovery of contractility and exclude tamponade.

Regular monitoring includes that of haemodynamics, ECG, oxygenation, blood and expired carbon dioxide, blood glucose, temperature and end-organ functions.

Frequent clinical assessments should be conducted and tests performed wherever possible to determine neurological status and to assist in prognosis.

2 Blood Pressure Maintenance

Peripheral circulatory failure (shock) is common after ROSC. At least the 5th centile of blood pressure appropriate for age should be maintained with the use of parenteral fluids and inotropic-vasopressor support[1] (CoSTR 2015, strong recommendation, very-low- quality evidence).

3 Ventilation and Carbon Dioxide Control

Although cerebral oedema could be expected after cardiac arrest, and hyperventilation is sometimes used as a temporary measure to reduce intracranial hypertension, hyperventilation results in hypocarbia which causes cerebral vasoconstriction and may impede venous return thus compromising blood pressure and consequently cerebral perfusion[1]. Effects of blood carbon dioxide partial pressure on cerebral perfusion have not been studied after paediatric cardiac arrest.

Normocarbia should be the target of post-arrest mechanical ventilation [Class B, Expert Consensus Opinion] unless a specific patient condition requires a different $PaCO_2$ target [1] (CoSTR 2015).

4 Oxygenation

Both hypoxaemia and hyperoxaemia are harmful. Normoxaemia should be targeted unless a different PaO_2 needs to be targeted for a patient specific condition (e.g. patients with cyanotic heart disease)[1] . ANZCOR recommends targeting the range of SpO_2 94-98%.

5 Targeted Temperature Management (TTM)

Insufficient trials have been conducted in infants and children to determine whether hypothermia (32°C-34°C) or normothermia (36°C-37.5°C) is clearly preferable[1], but therapeutic induced hypothermia for adults after VF cardiac arrest [2,3] [LOE II] and for newborns after birth asphyxia [4,5] [LOE I**]** favour induction of hypothermia to optimise neurological outcome. We suggest therapeutic temperature management (TTM) be used in the post-cardiac arrest period. While the ideal target temperature and duration are not known it is acceptable to induce hypothermia (32-34°C) or to target normothermia (36-37.5° C)[1] (CoSTR 2015, weak recommendation, moderate-quality evidence). This may require use of muscle relaxant to prevent shivering, use of sedation and EEG monitoring to detect otherwise unrecognizable convulsions. TTM should be instituted within 6 hours and maintained for 24 hours and up to 72 hours in children who remain comatose after resuscitation from cardiac arrest.

Hyperthermia after cardiac arrest in adults and animals is associated with a worse neurological outcome [1,6,7]. Hyperthermia should be prevented and treated aggressively after cardiac arrest [Class A; Expert Consensus Opinion].

6 Glucose Control

Poor neurological outcomes in adults after cardiac arrest are associated with spontaneous and induced elevated blood glucose levels while hypoglycaemia in the newborn infant exacerbates hypoxic induced brain injury [6,7]. Consequently, blood glucose levels should be monitored after cardiac arrest with the aim of maintaining normoglycaemia. If insulin is used to control hyperglycaemia, care should be taken to avoid hypoglycaemia [Class B; Expert Consensus Opinion]**.**

7 Prognosis and Prediction of Outcome

There is limited objective evidence on which to base a prognosis or to reliably foretell the outcome during paediatric resuscitation [1,6,7]. A factor which favours a better outcome, regardless of the location, is the observation of a shockable rhythm on the initial ECG [1]. During in-hospital cardiac arrest an age less than one year favours a better outcome whereas during out-of-hospital cardiac arrest an age greater than one year favours a better outcome [1]. The duration of cardiopulmonary resuscitation is not a reliable a reliable predictor of outcome [1].

Resuscitation in circumstances such as severe environmental hypothermia due to drowning in iced-water, or witnessed VF arrest, can result in better outcomes than average. It is acceptable [Class B, Expert Consensus Opinion] to continue resuscitation efforts longer in these circumstances. Long term outcome from paediatric cardiopulmonary arrest out-of-hospital is poor, but better if the arrest is respiratory alone or if cardiorespiratory arrest occurs in hospital [8,9].

In determining the prognosis after return of spontaneous circulation multiple rather than single clinical assessments and tests should be used. The latter include an electroencephalogram (within the first seven days), somatosensory evoked potentials after 72 hours, biomarkers of neuronal damage repeatedly over 72 hours, computerised axonal tomography in the initial hours and magnetic resonance imaging during the first 6 days [1]. (CoSTR 2015, weak recommendation, very-low-quality evidence).

It must be kept in mind that assessments made by clinical examination may need to be modified in their timing after the use of TTM or induced hypothermia.

8 Cessation of Cardiopulmonary Resuscitation

The decision to cease cardiopulmonary resuscitation should be based on a combination of factors including but not limited to the pre-arrest status, duration of arrest, response to resuscitation, remediable factors, duration and quality of resuscitation, likely outcome, opinions of experienced personnel, desires of parents and ready availability of extracorporeal life support for in-hospital arrest.

Although there are no highly reliable means of determining outcome, available scientific studies [6,7] have shown that, in the absence of reversible causes (e.g., poisoning, hypothermia as in iced-water drowning), prolonged resuscitative efforts for children are unlikely to be successful. Severe hypothermia may confound a diagnosis of cardiac arrest. If feasible, a child in cardiac arrest out-of-hospital should be transported to hospital if there has been any ROSC during resuscitation.

If a situation is deemed futile (such as the realisation that resuscitation is prolonging death rather than saving life) or not in the child's 'best interests', physicians can legally and ethically withdraw or withhold treatment, preferably with the agreement of a parent or legal guardian [10]. Healthcare professionals are under no legal obligation to persist indefinitely to try to save life in this circumstance [10] (Guideline 10.5).

9 Assisting parents

Parents should be kept closely informed of events. They should be given the opportunity but not coerced to be present at the resuscitation of their child [Class B; Expert Consensus Opinion]. A staff member should be assigned to be with them and support them during the process. Although parents and relatives may take solace in having witnessed the efforts of those involved [LOE II] they may also experience emotional trauma [11]. If family presence is negatively affecting the performance of the resuscitation by health-care personnel, the family should sensitively be asked to leave.[7] If resuscitation is unsuccessful or treatment is withdrawn or withheld, parents should be given the opportunity to be with their deceased child after equipment has been removed.

If a coronial enquiry is necessary, removal of devices may require permission from a coroner. Follow-up discussion should be routinely offered to parents

10 Assisting Staff

The requirement for CPR may be sudden as when a child collapses out-of-hospital and arrives unannounced to the Emergency Department or when a child's condition deteriorates rapidly on a ward or occurs as a result of mishap. These situations always test the readiness, skills and abilities of individuals and the organisation of institutions. It is prudent to monitor performance with a view to improvement and not ignore the psychological impact which such events have on individuals. Sensitive debriefing sessions should be encouraged along with regular education.

References

1. Maconochie IK, de Caen AR, Aickin R, Atkins DL, Biarent D, Guerguerian AM, Kleinman ME, Kloeck DA, Meaney PA, Nadkarni VM, Ng KC, Nuthall G, Reis AG, Shimizu N, Tibballs J, Pintos RV. Part 6: Pediatric basic life support and pediatric advanced life support 2015 International Consensus on cardiopulmonary Resuscitation and emergency Cardiovascular Care Science with Treatment Recommendations. Resuscitation 2015: 95: e147-e168.
2. Bernard SA, Gray WG, Buist MD, et al. Treatment of comatose survivors of out-of-hospital cardiac arrest with induced hypothermia. New Engl J Med 2002; 346: 557-63.
3. The Hypothermia after Cardiac Arrest Study Group. Mild therapeutic hypothermia to improve the neurologic outcome after cardiac arrest. New Engl J Med 2002; 346: 549-56.
4. Gluckman PD, Wyatt JS, Azzopardi D, et al. Selective head cooling with mild systemic hypothermia after neonatal encephalopathy: multicentre randomized trial. Lancet 2005; 365: 663-70.
5. Shankaran S, Laptook AR, Ehrenkranz RA, et al. Whole-body hypothermia for neonates with hypoxic-ischaemic encephalopathy. New Engl J Med 2005; 353: 1574-84.
6. Consensus on Science and Treatment recommendations. Part 6. Paediatric basic and advanced life support. Resuscitation 2005; 67: 271-91.
7. de Caen AR, Kleinman ME, Chameides L, Atkins DL, Berg RA, Berg MD, Bhanji F, Biarent D, Bingham R, Coovadia AH, Hazinski MF, Hickey RW, Nadkarni VM, Reis AG, Rodriguez-Nunez A, Tibballs J, Zaritsky AL, Zideman D, On behalf of the Paediatric Basic and Advanced Life Support Chapter Collaborators. Part 10: Paediatric basic and advanced life support: 2010 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science with Treatment Recommendations. Resuscitation 2010;81:e213–e259.
8. Young KD, Seidel JS. Paediatric cardiopulmonary resuscitation: a collective review. Annals of Emergency Medicine 1999; 33: 195-205.
9. Nadkarni VM, Larkin GL, Peberdy MA, et al. First documented rhythm and clinical outcome from in-hospital cardiac arrest among children and adults. JAMA 2006; 295: 50-57.

10. Skene L. Law and medical practice: Rights, Duties, Claims and Defences. 3rd edition, Australia, LexisNexis Butterworths, 2008.
11. Robinson SM, Mackenzie-Ross S, Campbell Hewson GL, Egleston CV, Prevost AT. Psychological effect of witnessed resuscitation on bereaved relatives. Lancet 1998; 352: 614-617.