ACTA MEDICA LITUANICA. 2012. Vol. 19. No. 3. P. 146–149

Outline of recent developments in CPR for children

Nigel Turner

Department of Perioperative Care and Emergency Medicine and Paediatric Intensive Care, Wilhelmina Children's Hospital, University Medical Centre, Utrecht, the Netherlands

Cardiac arrest in children is more often due to hypoxaemia or circulatory shock, which may have been present for some time, than to cardiac causes (1). As a result, significant organ damage has already occurred by the time of circulatory collapse and survival is generally poor. Survival with a good neurological outcome from out-of-hospital arrest in children varies from 0–12% but outcomes of up to 25% of patients have been reported from in-hospital arrest of mixed aetiology (2). Perioperative cardiac arrest in paediatric cardiac surgical patients has a higher survival.

Key words: cardiac arrest, hypoxaemia, circulatory shock, survival

RECOGNITION OF THE SEVERELY ILL CHILD

The introduction of a paediatric rapid-response team may reduce the incidence of in-hospital paediatric cardiac arrest and mortality (3, 4). The team is, however, unlikely to be effective unless the principles of the recognition of the seriously ill child are widely known such that the team can be called as early as necessary.

THE MANAGEMENT OF CIRCULATORY ARREST IN CHILDREN

The latest paediatric resuscitation guidelines were published by the European Resuscitation Council (ERC) in 2010 (Figs. 2 and 3; (11)).

Correspondence to: Nigel Turner, Department of Perioperative Care and Emergency Medicine and Paediatric Intensive Care, Wilhelmina Children's Hospital, University Medical Centre, PO Box 85500, 3508 GA Utrecht, the Netherlands.
E-mail: n.m.turner@umcutrecht.nl

Recognition of circulatory arrest

Healthcare professionals cannot reliably detect arterial pulses in children and the assessment of the pulse is no longer mandatory in the diagnosis of circulatory arrest. Only those with experience of clinical assessment should attempt to feel for pulses and must take no more than ten seconds to do so. The diagnosis of circulatory arrest is made on the basis of the absence of normal breathing and other signs of life, although this is also difficult, particularly for lay people, and there is no evidence that this is more reliable than a pulse check.

Compression and ventilation ratios

The guidelines continue to recommend a compression to ventilation ratio of 15 : 2 in children for healthcare professionals as opposed to 30 : 2 in adults, which leads to a relatively greater respiratory minute volume in children. Single, and lay rescuers may, however, use 30 : 2 which reduces the interruption to chest compressions by ventilation.

There is theoretical and epidemiological evidence that compression-only CPR leads to a worse outcome than conventional CPR in children (1). Compression-only CPR is, however, better than no CPR for those who are unable or unwilling to perform ventilation.

Quality of CPR

A major change in the new guidelines is the increase in the recommended frequency of chest compression from 100/min to *at least 100/min and not greater than 120/min*. The chance of survival in adult series and animal experiments improves with increases in the compression frequency up to 130–150 / minute (13). This is the basis for the change in the adult guidelines and the paediatric guidelines have been changed for consistency.

The depth of compression should be *at least* one third of the anterior-posterior chest diameter. Radiological evidence suggests that this corresponds to 3.4–5.1 cm in infants and 4.4–6.6 cm in older children, although there is no evidence that rescuers are able to assess the depth of compression in centimetres without feedback devices during resuscitation or training (15). Complete recoil of the thorax between compressions is important for optimal CPR but it remains unclear whether modified compression techniques, such as the hands-off technique, improve the quality of resuscitation (14).

Defibrillation

AED remains indicated in children from 1–8 years, in whom a device modified for paediatric use should be used, if available. There are case reports of successful defibrillation with AED in children younger than 1 year infants but the place of AED in resuscitation of infants is uncertain.

There is a suggestion in the literature that the use of AED may worsen the outcome from asystole or pulseless electrical activity (PEA), possibly by prolonging the interruption of chest compressions, and this is particularly concerning in children (16). If true, this would be an additional factor in the decision to use AED in children. Evidence from studies comparing the use of AED to no AED in out-of-hospital arrest in children is needed but such studies have not yet been reported.

Adrenaline

It is recommended to give adrenaline *after* recommencing chest compressions after the third shock, without a post-shock rhythm-check instead of before the shock. This change was made "on the basis of expert consensus" (13), but the rationale is not explained in the guidelines. The change is likely to reduce the hands-off time during CPR. Adrenaline causes arrhythmias and there is a reported risk of re-fibrillation from adrenaline administration following return of spontaneous circulation (ROSC). Resuscitation doses of adrenaline should therefore be avoided after successful defibrillation. However, considering that the effect of adrenaline persists for several minutes, this advantage is lost if defibrillation is successful, but undetected before adrenaline is given.

In a non-shockable rhythm, the first dose of adrenaline should be given as early as possible after commencing CPR.

Intravascular access

The use of intraosseous devices in patients of all ages is safe, effective and increasing, possibly due to the wide availability of semi-automatic devices such as the IO-drill. It is currently recommended to limit attempts at venous cannulation to one minute before inserting an intraosseous device, but this may be inserted earlier, or even before attempting venous cannulation.

Anti-arrhythmic drugs

Amiodarone is more effective in malignant ventricular arrhythmias than lignocaine, which should only be used when amiodarone is not available. The two drugs should not be combined. The timing of amiodarone – after the third and the fifth shock – is unchanged.

Amiodaron, being a class III antiarrhythmicum, might not be the best choice in malignant ventricular dysrhythmias due to Long QT syndromes (LQTS). The relative incidence of LQTS as the cause of VF in children is, however, not precisely known.

Diagnosis of the cause of circulatory arrest

Unexpected sudden cardiac arrest in children and young people should alert the physician to the

possibility of a channelopathy, such as in many types of Long QT syndrome. In such cases, post-mortem examination is advised, although this would be mandatory in many countries, such as the Netherlands.

POST-RESUSCITATION THERAPEUTIC HYPOTHERMIA

Induced hypothermia is widely used in children following circulatory arrest, although unequivocal evidence of a positive effect on neurological outcome is still lacking (17). The current recommendation is to consider cooling after ROSC (11). This is extrapolated from reasonable evidence of effect in adults and neonates (18, 19). There is too little evidence to recommend a particular regime or target temperature. Temperatures of 32–34 °C for up to 72 hours are safe, but lower temperatures may be associated with increased mortality (20).

Received 19 July 2012
Accepted 1 August 2012

References

(including some interesting references not cited in the text)

1. Kitamura T, Iwami T, Kawamura T, Nagao K, Tanaka H, Nadkarni VM, et al. Conventional and chest-compression-only cardiopulmonary resuscitation by bystanders for children who have out-of-hospital cardiac arrests: a prospective, nationwide, population-based cohort study. Lancet. 2010; 375(9723): 1347–54.
2. Atkins DL, Everson-Stewart S, Sears GK, Daya M, Osmond MH, Warden CR, et al. Epidemiology and outcomes from out-of-hospital cardiac arrest in children: the Resuscitation Outcomes Consortium Epistry-Cardiac Arrest. Circulation. 2009; 119(11): 1484–91.
3. Brilli RJ, Gibson R, Luria JW, Wheeler TA, Shaw J, Linam M, et al. Implementation of a medical emergency team in a large pediatric teaching hospital prevents respiratory and cardiopulmonary arrests outside the intensive care unit. Pediatr Crit Care Med. 2007; 8(3): 236–46.
4. Tibballs J, Kinney S, Duke T, Oakley E, Hennessy M. Reduction of paediatric in-patient cardiac arrest and death with a medical emergency team: preliminary results. Arch Dis Child. 2005; 90(11): 1148–52.
5. Advanced Life Support Group. Advanced Paediatric Life Support: The practical approach. 4th ed. London: BMJ Books; 2005. ISBN-10: 0727918478.
6. Schriger DL, Baraff L. Defining normal capillary refill: variation with age, sex, and temperature. Ann Emerg Med. 1988; 17(9): 932–5.
7. Anderson B, Kelly AM, Kerr D, Clooney M, Jolley D. Impact of patient and environmental factors on capillary refill time in adults. Am J Emerg Med. 2008; 26(1): 62–5.
8. Turner NM. A practical approach to paediatric emergencies in the radiology department. Pediatr Radiol. 2009; 39(5): 423–32.
9. Kilgannon JH, Jones AE, Shapiro NI, Angelos MG, Milcarek B, Hunter K, et al. Association between arterial hyperoxia following resuscitation from cardiac arrest and in-hospital mortality. JAMA. 2010; 303(21): 2165–71.
10. Koch JD, Miles DK, Gilley JA, Yang CP, Kernie SG. Brief exposure to hyperoxia depletes the glial progenitor pool and impairs functional recovery after hypoxic-ischemic brain injury. J Cereb Blood Flow Metab. 2008; 28(7): 1294–306.
11. Biarent D, Bingham R, Eich C, Lopez-Herce J, Maconochie I, Rodriguez-Nunez A, et al. European Resuscitation Council Guidelines for Resuscitation 2010 Section 6. Paediatric life support. Resuscitation. 2010; 81(10): 1364–88.
12. Losert H, Sterz F, Roine RO, Holzer M, Martens P, Cerchiari E, et al. Strict normoglycaemic blood glucose levels in the therapeutic management of patients within 12 h after cardiac arrest might not be necessary. Resuscitation. 2008; 76(2): 214–20.
13. Nolan JP, Soar J, Zideman DA, Biarent D, Bossaert LL, Deakin C, et al. European Resuscitation Council Guidelines for Resuscitation 2010 Section 1. Executive summary. Resuscitation. 2010; 81(10): 1219–76.
14. Sayre MR, Koster RW, Botha M, Cave DM, Cudnik MT, Handley AJ, et al. Part 5: Adult basic life support: 2010 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science with Treatment Recommendations. Circulation. 2010; 122(16 Suppl 2): S298–324.
15. Kao PC, Chiang WC, Yang CW, Chen SJ, Liu YP, Lee CC, et al. What is the correct depth of chest

compression for infants and children? A radiological study. Pediatrics. 2009; 124(1): 49–55.
16. Forcina MS, Farhat AY, O'Neil WW, Haines DE. Cardiac arrest survival after implementation of automated external defibrillator technology in the in-hospital setting. Crit Care Med. 2009; 37(4): 1229–36.
17. Scholefield BR, Duncan HP, Morris KP. Survey of the use of therapeutic hypothermia post cardiac arrest. Arch Dis Child. 2010; 95(10): 796–9.
18. Simbruner G, Mittal RA, Rohlmann F, Muche R. Systemic hypothermia after neonatal encephalopathy: outcomes of neo.nEURO.network RCT. Pediatrics. 2010; 126(4): e771–8.
19. Bernard SA, Gray TW, Buist MD, Jones BM, Silvester W, Gutteridge G, et al. Treatment of comatose survivors of out-of-hospital cardiac arrest with induced hypothermia. N Engl J Med. 2002; 346(8): 557–63.
20. Fink EL, Clark RS, Kochanek PM, Bell MJ, Watson RS. A tertiary care center's experience with therapeutic hypothermia after pediatric cardiac arrest. Pediatr Crit Care Med. 2010; 11(1): 66–74.
21. Davis PG, Tan A, O'Donnell CP, Schulze A. Resuscitation of newborn infants with 100% oxygen or air: a systematic review and meta-analysis. Lancet. 2004; 364(9442): 1329–33.
22. Richmond S, Wyllie J. European Resuscitation Council Guidelines for Resuscitation 2010 Section 7. Resuscitation of babies at birth. Resuscitation. 2010; 81(10): 1389–99.

Nigel Turner

NAUJI VAIKŲ GAIVINIMO PASIEKIMAI (APŽVALGA)

Santrauka

Vaikų širdis sustoja dažniau dėl jau kurį laiką galimai esančios hipoksemijos ar cirkuliacinio šoko nei dėl širdies priežasčių. Dėl to kraujotakos kolapso metu organai jau būna labai pažeisti, o išgyvenamumas dažniausiai yra prastas. Vaikų, kuriems širdis sustoja ne ligoninėje, išgyvenamumas su gera neurologine išeitimi svyruoja nuo 0 iki 12 %, o ligoninėje įvykusio mišrios etiologijos širdies sustojimo atveju – iki 25 %. Vaikų širdies chirurgijos pacientai, kuriems perioperaciniu laikotarpiu sustojo širdis, pasižymi didesniu išgyvenamumu.

Raktažodžiai: širdies sustojimas, hipoksemija, cirkuliacinis šokas, išgyvenamumas