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/min (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.

Amiodarone, being a class III antiarrhythmium, 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-RESCUSCITATION 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).

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References

(including some interesting references not cited in the text)


