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Resuscitation 48 (2001) 231–324

RESUSCITATION

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European Resuscitation Council Guidelines 2000 for Advanced Paediatric Life Support

A statement from Paediatric Life Support Working Group and approved by the Executive Committee of the European Resuscitation Coucil

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1. Introduction

European Resuscitation Council (ERC) last issued guidelines for Paediatric Life Support (PLS) in 1998 [1]. These were based on the 'Advisory Statements' of the International Liaison Committee on Resuscitation (ILCOR) published in 1997 [2]. Following this, the American Heart Association, together with representatives from ILCOR, undertook a series of evidence based evaluations of the science of resuscitation which culminated in the publication of 'Guidelines 2000 for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care' in August 2000 [3,4]. The Paediatric Life Support Working Party of the European Resuscitation Council has considered this document and the supporting scientific literature and has recommended changes to the ERC Advanced PLS Guidelines. These are presented in this paper. There have been few major changes to the ERC recommended guidelines as some of the changes agreed in 'Guidelines 2000' had already been introduced into Europe subsequent to the 1998 ILCOR 'Advisory Statements' (Fig. 1).

2. Guidelines changes

The approach to changes has been to alter the guidelines in response to convincing new scientific evidence and, where possible, to simplify the guidelines in order to assist teaching and retention.

There is a paucity of experimental evidence, both old and new, to inform the development of guidelines for paediatric resuscitation. Some alterations, therefore, have been made in response to evidence from animal work, studies in adults and to aid consistency between adult and paediatric guidelines where this was consistent with paediatric resuscitation needs.

The changes in advanced life support for infants and children are as follows:

1. ***Use of bag-mask ventilation.*** Proficiency in bag-mask ventilation is vital for ALS providers. The method of advanced airway and ventilation support (bag-mask or tracheal intubation or laryngeal mask) should be provided on the basis of the audited skills of the provider and the characteristics of the arrested patient [5].
2. ***Confirmation of tracheal tube placement.*** Confirmation of satisfactory tracheal tube placement is required for patients with a perfusing rhythm by capnography or exhaled CO_2 detection.
3. ***Circulatory access.*** For patients who had no acceptable vascular access in situ before arrest, immediate intraosseous access is recommended for the administration of medications. The use of the intraosseous route is extended to children of all ages.

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PII: S0300-9572(00)00381-6

4. ***Second epinephrine dose.*** There is no convincing evidence that a tenfold increase in epinephrine dose is beneficial in children and in some adult studies a deleterious effect was observed [6–8]. However, there are some anecdotal cases of return of spontaneous circulation with large doses of epinephrine and therefore it can still be used for second and subsequent doses in patients where cardiac arrest is thought to have been secondary to circulatory collapse. It is clear that patient response to epinephrine is very variable, therefore if the patient has continuous intra-arterial monitoring the epinephrine dose can be titrated to best effect. In the absence of indicators to the contrary, the usual second and subsequent dose of epinephrine will be 10 mcg/kg.
5. ***Anti-arrhythmic drugs.*** Amiodarone is now the treatment of choice in shock resistant ventricular fibrillation and pulseless ventricular tachycardia. This is based on evidence from adult cardiac arrest and experience with the use of amiodarone in children in the catheterisation laboratory setting. The dose of amiodarone for VF/pulseless VT is 5 mg/kg via rapid i.v. bolus followed by continued basic life support and a further defibrillation attempt within 60 s. Lignocaine remains an acceptable alternative. Magnesium should be used (25–50 mg/kg) if there is torsades de pointes.
6. ***Use of automated external defibrillators (AEDs).*** AEDs may be used in children over the age of 8 years (25 kg or over). Below this age they may be used for rhythm recognition

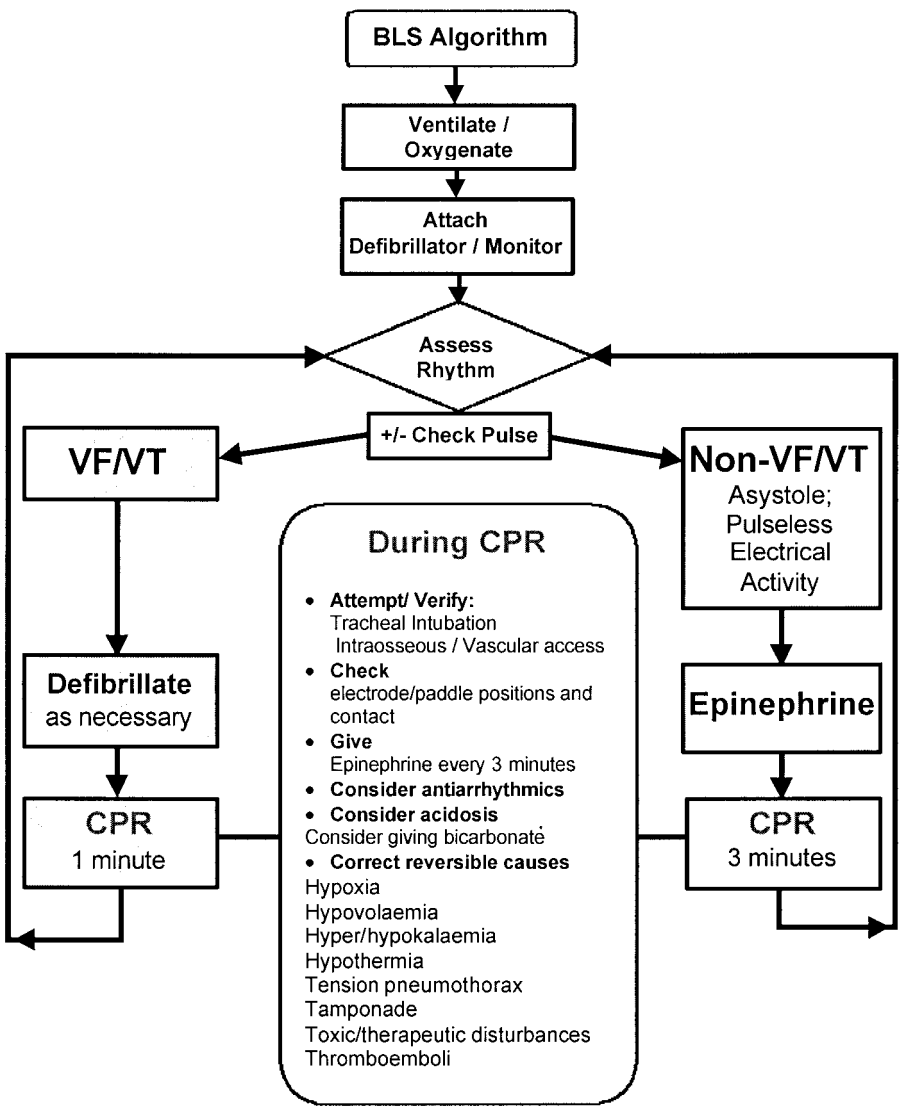

Fig. 1. Advanced Paediatric Life Support.

(although in infants they may not be accurate in identifying tachyarrhythmias) but the defibrillation dose delivered cannot currently be recommended [9,10].

3. Sequence of actions

1. Establish basic life support

2. Oxygenate, ventilate

Provide positive pressure ventilation with a high-inspired oxygen concentration.

3. Attach a defibrillator or monitor

Monitor the cardiac rhythm:

- Place the defibrillator pads or paddles on the chest wall; one just below the right clavicle, the other at the left anterior axillary line.
- For infants, when using this method of monitoring, it may be more appropriate to apply the pads or paddles to the front and back of the infant's chest.
- Place monitoring electrodes in the conventional chest positions and monitor with a cardiac monitor.

4. Assess Rhythm (± check for pulse)

Check the pulse

Child — feel for the carotid pulse in the neck.

Infant — feel for the brachial pulse on the inner aspect of the upper arm.

Take *no more than 10 s*

Assess the rhythm on the monitor as being:

- Non-ventricular fibrillation (non-VF) or non pulseless ventricular tachycardia (non-VT) (asystole or pulseless electrical activity).
- Ventricular fibrillation (VF) or pulseless ventricular tachycardia (VT).

5A. Non-VF/VT — asystole, pulseless electrical activity

This is more common in children.

Administer epinephrine.

- If direct venous or intraosseous access has been established, give 10 mcg/kg adrenaline (epinephrine) (0.1 ml/kg of 1 in 10 000 solution).
- If venous or intraosseous access has not been established but the child is already intubated consider giving 100 mcg/kg adrenaline (epinephrine) via the tracheal tube (1 ml/kg of 1 in 10 000 or 0.1 ml/kg of 1 in 1000 solution).

Perform 3 min of CPR.

Repeat the administration of adrenaline epinephrine.

- Give 10–100 mcg/kg (0.1ml/kg of 1 in 10 000–0.1 ml/kg of 1 in 1000 solution) by the intravenous or intraosseous route and perform a further 3 min of CPR.

Continue the cycles of 10–100 mcg/kg epinephrine followed by 3 min of CPR.

Consider the use of other medications such as alkalising agents and a fluid bolus and treat reversible causes.

5B. VF/VT

This is less common in paediatric life support but the rescuer must always be aware of the need to treat this arrhythmia rapidly and effectively.

Defibrillate the heart with three defibrillation shocks: 2J/kg, 2J/kg, 4J/kg (accuracy of dosage may be difficult using defibrillators with stepped energy levels).

- Place the defibrillator pads or paddles on the chest wall; one just below the right clavicle, the other at the left anterior axillary line.
- For infants, when using this method of monitoring, it may be more appropriate to apply the pads or paddles to the front and back of the infant's chest.

If VF/VT persists give the first dose of epinephrine, 10 mcg/kg and perform one minute of CPR. Do not interrupt CPR for anything except defibrillation.

Defibrillate the heart with three defibrillation shocks: 4J/kg, 4J/kg, 4J/kg.

Repeat the cycle of defibrillation and CPR until defibrillation is achieved. Consider the use of other medications such as antiarrhythmics and alkalising agents. Give adrenaline (epinephrine) 10–100 mcg/kg every 3–5 min. After each medication there should be half to 1 min of CPR to distribute the drug before the next shock. Treat reversible causes such as hyperkalaemia, poisoning and hypothermia.

Advanced life support procedures

- Establish a definitive airway.
  Attempt tracheal intubation.
  Verify the position of the tracheal tube by auscultation and by capnography or carbon dioxide detection.

- Establish ventilation
  Ventilate with 100% oxygen using a self-inflat-

ing resuscitation bag with a reservoir or a high flow system with a T-piece.

- Establish vascular access
  Gain access to the circulation by:
  Direct venous access
  Intraosseous access
- Give adrenaline (epinephrine) every 3 min
- Consider anti-arrhythmic agents
- Consider giving bicarbonate to correct a severe acidosis
- Correct reversible causes:

  Hypoxia;
  Hypovolaemia;
  Hyper/hypokalaemia;
  Hypothermia;
  Tension pneumothorax;
  Tamponade;
  Toxic/therapeutic disturbances;
  Thromboemboli.

References

[1] Paediatric Life Support Working Group of the European Resuscitation Council. The 1998 European Resuscitation Council guidelines for paediatric life support. Resuscitation 1998;37:95–113.

[2] Nadkarni V, Hazinski M, Zideman D, Kattwinkel J, Quan L, Bingham R, Zaritsky A, Bland J, Kramer E, Tiballs J. Paediatric life support. An advisory statement by the Paediatric Life Support Working Group of the International Liaison Committee on Resuscitation. Resuscitation 1997;34(2):115–27.

[3] American Heart Association in collaboration with the International Liaison Committee on Resuscitation (ILCOR). Guidelines 2000 for cardiopulmonary resuscitation and emergency cardiovascular care — an international consensus on science. Resuscitation 2000;46:1–447

[4] American Heart Association in collaboration with the International Liaison Committee on Resuscitation (ILCOR). Guidelines 2000 for cardiopulmonary resuscitation and emergency cardiovascular care. An international consensus on science. Circulation 102(Suppl. I): I-1–I-384

[5] Gausche M, Lewis RJ, Stratton SJ, et al. A prospective randomised study of the effect ofout-of-hospital pediatric endotracheal intubation on survival and neurological outcome. JAMA 2000;283:783–90.

[6] Berg RA, Otto CW, Kern KB, et al. A randomised, blinded trial of high-dose epinephrine versus standard dose epinephrine in a swine model of pediatric asphyxial cardiac arrest. Crit Care Med 1996;24:1695–700.

[7] Carpenter TC, Stenmark KR. High dose epinephrine is not superior t. standard-dose epinephrine in pediatric in-hospital cardiopulmonary arrest. Pediatrics 1997;99:403–8.

[8] Tang W, Weil MH, Sun S, et al. Epinephrine increases the severity of postresucitation myocardial dysfunction. Circulation 1995;92:3089–93.

[9] Atkins DL, Hartley L, York D. Accurate recognition and effective treatment of ventricular fibrillation by automated external defibrillators in adolescents. Pediatrics 1998;110:393–7.

[10] Hazinsky MF, Walker C, Smith H, Desapande J. Specificity of automatic external defibrillator rhythm analysis in pediatric tachyarrhythmias. Circulation 1997;96(Suppl.):1–561.