Update in Anaesthesia

Paediatric life support

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Summary

Children usually suffer cardiac arrest secondary to hypoxia or ischaemia due to respiratory or circulatory failure.

Cardiac arrest is commonly reversed by simple interventions.

Early recognition of a child at risk of deterioration is essential.

Avoid interruptions in chest compressions.

There are some differences between resuscitation techniques for children and adults but there are also many similarities. There is no doubt that a child in cardiorespiratory arrest will be harmed more by doing nothing than by using adult resuscitation guidelines.

Children usually suffer from secondary cardiac arrest – the heart stops secondary to hypoxia or ischaemia caused by respiratory or circulatory failure. The main implication of this is that there is potential to recognise the primary cause early on and prevent its progression to full blown arrest. Respiratory or circulatory failure is initially compensated by the body's physiological mechanisms and the signs are fairly subtle.

Signs of compensated respiratory failure

- Tachypnoea or bradypnoea (e.g. in narcotic overdose)
- Increased work of breathing:
  - Anxious appearance
  - Use of accessory muscles of respiration
  - Noises – stridor, grunting or wheeze
  - Nasal flaring.

Signs of compensated circulatory failure

- Tachycardia
- Slow capillary refill
- Cool peripheries
- Thirst
- Lethargy.

In the compensated phase there are good opportunities to prevent deterioration by the administration of general treatment such as oxygen and fluid (in circulatory failure) and specific treatments such as salbutamol in asthma and antibiotics in pneumonia or sepsis. This compensated phase may progress to decompensation, however and, if immediate action is not then taken, to cardiorespiratory arrest.

Signs of decompensation

Diminishing level of consciousness is an important sign of decompensation and imminent arrest

In addition, for decompensating respiratory failure

- Sudden fall in respiratory rate
- Exhaustion
- Very quiet or silent chest.

Decompensating circulatory failure

- Hypotension
- Sudden fall in heart rate.

Fortunately, the actions required to reverse this process are usually simple and follow the familiar ABC format.

COMMENTARY - BASIC LIFE SUPPORT (Figure 1)

A – Airway

Opening a child's airway is similar to opening that of an adult – a head tilt and chin lift. The most important difference is to avoid pressing on the soft tissues underneath the jaw as this pushes the tongue backwards into the oropharynx and can worsen airway obstruction. Infants have a prominent occiput and simply require the head to be placed in a neutral position – overextension is not helpful. If this simple manoeuvre is ineffective a jaw thrust (performed in the same way to that in adults) usually works.

Sometimes an airway adjunct is required and the most useful is an oropharyngeal airway. The size is selected so that tip of the airway is level with the angle of the jaw when the flange is lined up with the lips. It can be inserted in the same way as for an adult airway (i.e. introduced upside down and then rotated 180 degrees into its final position) but care should be taken not to damage the hard palate.

Successful opening of the airway should be assessed by ***looking*** (for chest movement), ***listening*** (for air flow at the nose and mouth) and ***feeling*** (for expired air on your cheek held close to the child's nose and mouth).

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- If there is chest movement and you can hear and feel expired air then the airway is clear and oxygen (if available) should be given.
- If there is chest movement but no expired air then the airway is still obstructed and it should be repositioned.
- If there is no chest movement, positive pressure ventilation is required.

B – Breathing

Positive pressure ventilation (IPPV) may be given with expired air (mouth to mouth) or bag mask ventilation (BMV) with a self-inflating bag/mask system.

Mouth to mouth ventilation requires no equipment but is inefficient as it only delivers expired oxygen concentrations (about 17%). Nevertheless it can be lifesaving.

The most important points are to open the airway effectively (as above) and to achieve a good seal with your lips over the child's mouth (or nose and mouth in a small infant). You should deliver enough breath to make the child's chest rise as if they had taken a normal breath.

The same principles apply to BMV – the airway should be open and there should be a good seal, this time between the mask rim and the child's face. If this is difficult it may help to have 2 people – one to do a jaw thrust and to achieve a seal with the mask using both hands and the other to squeeze the reservoir bag. Again, the aim is to make the chest rise as if the child has taken a normal breath. Five rescue breaths should be delivered in this fashion and then an assessment of the circulation should be made.

C – Circulation

In diminished level of consciousness due to decompensated respiratory or circulatory failure, failure to respond to positive pressure ventilation by moving, coughing or resuming breathing is a sure sign of absence of an effective circulation and external chest compression (ECC) should be immediately commenced. Prolonged searching for a pulse (>10 seconds) is unnecessary may result in error or delay.

ECC is performed by compression of the chest to a depth of 1/3 to 1/2 of the A-P diameter, at a point just (1 finger's breadth) above the xiphisternum. Don't be afraid of pushing too hard. Compressions should be at a rate of 100 per minute and 2 breaths should be given after every 15 compressions. Compressions should be interrupted as little as possible so, if the trachea is intubated, they should be continuous with about 10 breaths delivered every minute. Generally, people ventilate too vigorously during resuscitation and this has been shown to impede venous return and reduce blood flow.

If a monitor or defibrillator is available it should be applied to check whether there is a shockable cardiac rhythm (ventricular fibrillation or ventricular tachycardia) or not. Adrenaline (10mcg.kg^{-1}) should be given every 3-5 minutes during ECC as it increases cerebral and myocardial perfusion.

COMMENTARY - ADVANCED LIFE SUPPORT (Figure 2)

1. Shockable rhythms - ventricular fibrillation (VF) or pulseless ventricular tachycardia (pVT)

If a shockable rhythm is present defibrillation with 4J.kg^{-1} should be performed immediately. Chest compression should be restarted immediately even if a rhythm change is seen on the monitor. This is important, as the heart will not be able to support the circulation for a minute or so, even if sinus rhythm resumes. If defibrillation is unsuccessful, CPR should be continued for a further 2 minutes and the defibrillation cycle repeated. If a third shock is necessary, epinephrine (adrenaline) should be given immediately before and an anti-arrhythmic should be used before a fourth shock. Amiodarone (5mg.kg^{-1}), where available, is preferred but lidocaine (1mg.kg^{-1}) is an acceptable alternative.

2. Non-shockable rhythm - asystole or pulseless electrical activity (PEA)

If the rhythm is not shockable, the emphasis is on good quality CPR with minimum interruption in ECC together with adrenaline administration every 3-5 minutes.

3. Reversible causes

In both shockable and non-shockable rhythms treatable causes should be sought and dealt with. Children rarely suffer from primary heart disease, so there is often a precipitating cause and resuscitation will not be successful if this is not removed. Treatable causes can be remembered by the 4Hs and the 4Ts mnemonic.

4**Hs**	4**Ts**
Hypoxia	**T**ension pneumothorax
Hypovolaemia	Cardiac **T**amponade
Hypo/hyperkalaemia	**T**oxicity
Hypothermia	**T**hromboembolism

4. Other points

Drugs

By far the most important treatment in resuscitation is good quality basic life support with continuous chest compression and effective, but not excessive, lung inflation. The next important action is to remove any reversible precipitating causes. Although drugs are commonly administered, there is little evidence to support routine administration of many of them. As the tracheal route of administration is largely ineffective, circulatory access had to be achieved rapidly; this is most effectively performed by intraosseous cannulation unless a peripheral vein can be accessed immediately.

Oxygen

This is the most important drug in paediatric resuscitation as many arrests in children are due to hypoxia. Although high concentrations are often used, effective airway opening and lung inflation are by far the most important steps in achieving adequate oxygenation.

Epinephrine (adrenaline)

Epinephrine been shown to increase the chances of restoring spontaneous circulation and should be administered in a dose of 10mcg.kg^{-1} every 3-5 minutes during resuscitation. Larger doses have not been shown to be effective and should not be used.

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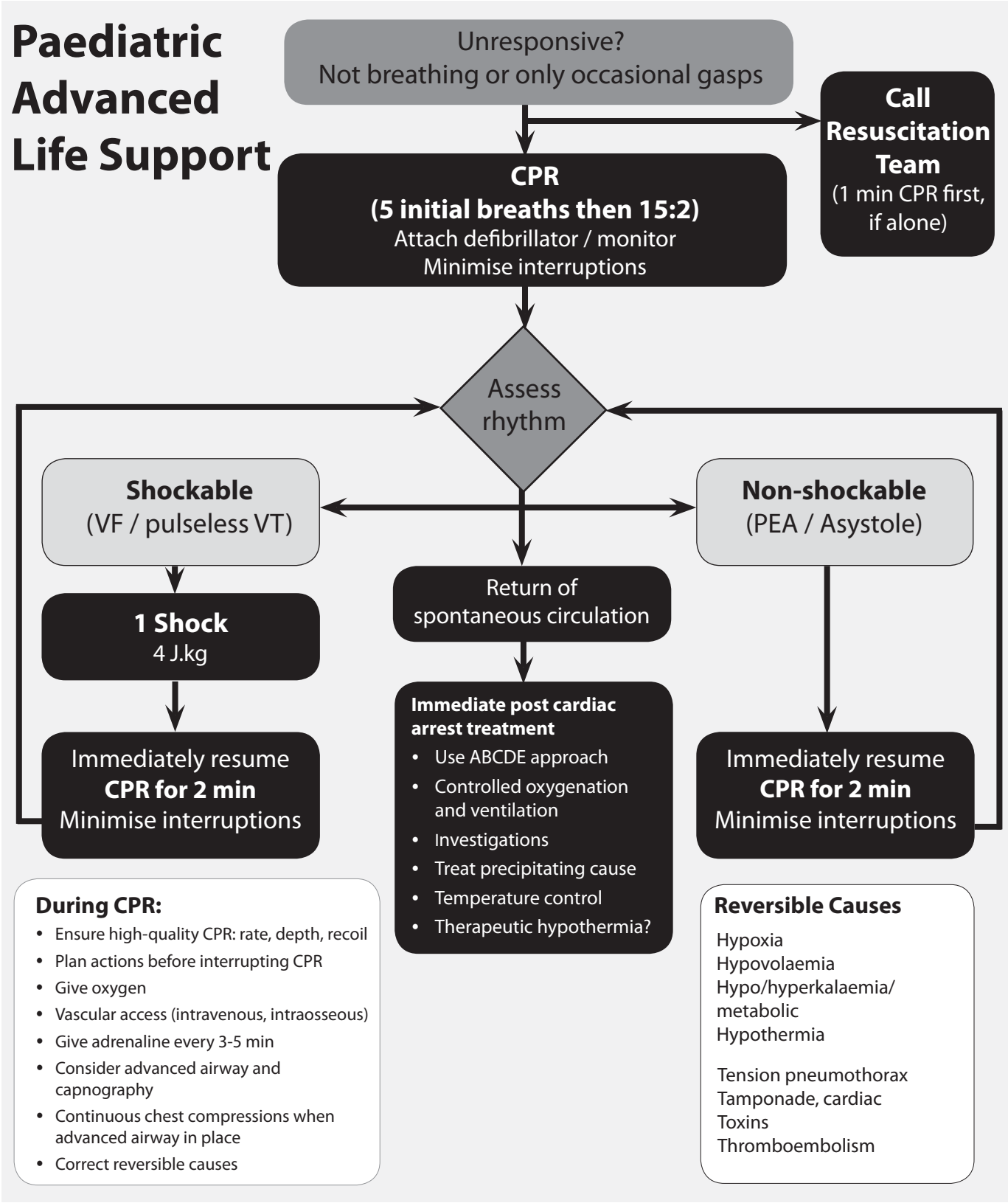

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Figure 2. *Reproduced by kind permission of the European Resuscitation Council and available at*: www.resus.org.uk/pages/palspost.pdf

Sodium bicarbonate ($NaHCO_3$)

Bicarbonate neutralises acidosis by releasing carbon dioxide. During resuscitation, this cannot be cleared as there is insufficient pulmonary gas exchange, consequently, it has not been shown to be effective and should not be used routinely. $NaHCO_3$ may be indicated in specific circumstances such as hyperkalaemia or in drug toxicity (e.g. tricyclic antidepressants).

Calcium has not been shown to be effective in resuscitation and it may even be harmful, consequently it should not be used routinely. It may however, be effective in hyperkalaemia, hypocalcaemia and calcium receptor blocker overdose.

Amiodarone (5mg.kg^{-1}) has been shown to be the most effective anti-arrhythmic in resistant VF or pVT but lidocaine is an acceptable alternative. Amiodarone is incompatible with saline and should be diluted in 5% glucose.

OUTCOMES

Although it is often thought that children have extremely poor outcome after cardiac arrest, this is not entirely true. Large North American databases have shown that children that have a full cardiac arrest in a hospital have a 27% chance of survival to discharge and that 75% of these will have a good neurological outcome. Out of hospital resuscitation has poorer survival rates, but these figures are significantly biased by infants with sudden infant death syndrome (SIDS). Older children and adolescents have survival rates of about 9%.

Children with respiratory arrest only who haven't progressed to full cardiac arrest have an excellent chance of survival with about 70% alive after 1 year.

SUMMARY

The most important intervention in paediatric resuscitation is early recognition of the child at risk of deterioration and the instigation of treatment intended to prevent progression to cardio-respiratory arrest.

Once cardio-respiratory arrest has occurred, early and good quality CPR is the most important step for a favourable outcome. Interruptions in chest compression should be avoided and compressions can be continuous once the trachea is intubated. Reversible causes should be actively sought and treated as many paediatric arrests are secondary to another event.

REFERENCES

Bingham B. Paediatric life support. Update in Anaesthesia 2009 25(2):31-37. Available from: http://www.wfsahq.org/components/com_virtual_library/media/4ffc7f76113dd649ce4ff5a2b1dd607c-Paediatric-Life-Support--Update-25-2-2009-.pdf

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