

# Australian Resuscitation Council: Paediatric advanced life support (PALS) guidelines 2006

James Tibballs

This article summarises the updated Paediatric Advanced Life Support (PALS) guidelines, which are published in full on the Internet (<http://www.resus.org.au>). These guidelines are intended for resuscitation of infants (<1 year) and children (1–14 years) by health care personnel, including medical and nursing staff and ambulance officers.

## Diagnosis of cardiorespiratory arrest

Cardiorespiratory arrest should be suspected when there are no "signs of life". If the victim is unconscious (unresponsive), not moving and not breathing adequately, cardiopulmonary resuscitation should be commenced with basic techniques until equipment, electrocardiography monitoring and drugs are at hand. Additional signs of arrest are pallor, cyanosis and absence of a pulse. Reliance should not be placed on pulse palpation alone — if a pulse cannot be identified within 10 seconds, cardiopulmonary resuscitation should be commenced.

## Management of cardiorespiratory arrest

Essential techniques are preservation of an airway, mechanical ventilation of the lungs with oxygen, external chest compression, treatment of cardiac arrhythmias with drugs and treatment of causative conditions (Figure).

Mechanical ventilation of the lungs with oxygen should be commenced initially with bag–valve–mask ventilation with or without an oropharyngeal airway. Thereafter, endotracheal intubation may be advantageous, but valuable time should not be wasted with repeated unsuccessful attempts.

## Endotracheal intubation

For a child, the appropriate internal diameter for an endotracheal tube (ETT) is: diameter (mm)=age (years)/4+4. The appropriate depth of insertion is: depth (cm)=age (years)/2 + 12 for an oral tube (from the lips); and depth (cm) = age (years)/2 + 15 for a nasal tube (from the nares).

For an infant, the appropriate internal diameter of an ETT is 3.5 mm (for age up to 6 months) and 4 mm (for age, 7 months to 1 year). The depth of oral insertion is 9.5 cm (for newborn), 11.5 cm (for age, 6 months) and 12 cm (for

age, 1 year). Depth should be extrapolated for ages between these. It is preferable to check depth of insertion by chest x-ray.

## Confirmation of intubation

Inadvertent oesophageal or bronchial intubation at intubation or dislodgement of the tube during resuscitation is possible. Immediately after intubation, and during the course of resuscitation, the position of the tube must be checked with visual inspection of chest inflation, auscultation of breath sounds in the axillae, measurement of oxygenation and a technique of carbon dioxide detection in exhaled breath (capnography or a colourmetric technique). Carbon dioxide detection is a rapid and reliable detector of correct tracheal tube placement but is only possible if there is cardiac output.

## Access to the circulation

If access to the circulation is not already present, peripheral venous cannulation should be attempted immediately. If this is not successful within 60–90 seconds, a needle should be inserted into bone marrow (intraosseous [IO]). Easily accessible sites are the anteromedial surfaces of the upper and lower tibia. All resuscitative drugs and fluids may be injected into bone marrow. Central venous cannulation is difficult in the setting of cardiopulmonary arrest. If intravenous (IV) or IO access is impossible, some drugs in doses larger than IV doses (adrenaline, atropine, lignocaine and naloxone) may be given via the endotracheal tube.

## Chest compression

The lower sternum should be compressed to about one third of the anterior–posterior diameter of the chest. The preferred technique for infants is the two-thumb technique, in which the hands encircle but do not constrict the chest. The two-finger technique may be preferred by a single rescuer who must transfer between chest compressions and lung inflation. For children, either the heel of one hand or the two-hand technique may be used, depending on the relative sizes of the victim's chest and the rescuer's hands, and the strength of the latter.

# Paediatric Cardiorespiratory Arrest

**Basic CPR**  
Compression - Ventilation Ratio 30: 2

**Advanced CPR**  
Compression - Ventilation Ratio 15: 2

**Attach Defibrillator – ECG Monitor**

**Assess Rhythm**

**Shockable**  
VF / Pulseless VT

**Non-Shockable**  
PEA / Asystole

**One DC Shock<sup>1</sup>**  
Biphasic or  
Monophasic  
2J/kg

**Immediate**  
CPR 2 min

**One DC Shock<sup>2</sup>**  
Biphasic or  
Monophasic  
4J/kg

**Immediate**  
CPR 2 min

## During CPR

Check electrode/paddle positions & contact  
Attempt/verify/secure IV / IO access  
**Correct Reversible Causes**

- Hypoxaemia
- Hypovolaemia
- Hypo/Hyperkalaemia
- Hypo/Hyperthermia
- Tamponade
- Tension pneumothorax
- Toxins / Poisons / Drugs
- Thromboembolism

### Consider:

**Intubation / Advanced Airway**

**Vasopressor**  
Adrenaline 10 mcg/kg every 3 min

### Antiarrhythmic

Amiodarone 5 mg/kg **OR**  
Lignocaine 1 mg/kg for VF/VT.  
Magnesium 0.1 - 0.2 mmol/kg for  
*Torsade de pointes*

### Buffer

NaHCO<sub>3</sub> 1 mmol/kg

**Atropine 20mcg/kg + Pacing**  
(for asystole & severe bradycardia)

**Adrenaline**  
10 mcg/kg IV / IO

**Continue**  
CPR 2 min



<sup>1</sup> For witnessed arrest, give up to 3 stacked shocks (2,4,4 J/Kg) at first defibrillation attempt.

<sup>2</sup> If further shocks are needed these should be single shocks 4J/kg.

### Rates and ratios of chest compression and lung ventilation

The universal rate of chest compression is about 100 per minute (ie, about 2 per second). The ratio of chest compression to lung ventilation used in basic life support is 30:2. With coordinated pauses for breaths with 1 second inspiratory phases, about 5 cycles can be achieved in 2 minutes (ie, about 75 compressions and 5 breaths per minute).

The ratio of chest compression to lung inflation in advanced resuscitation by health care personnel is 15:2. During bag–valve–mask ventilation, pauses are required for ventilation, which would enable about 5 cycles per minute, yielding about 75 compressions and 10 breaths. After tracheal intubation, chest compressions at about 100 per minute are continuous, and ventilations are asynchronous, but care is necessary to avoid hyperventilation which impedes venous return and causes hypocapnic cerebral ischaemia.

### Pulseless arrhythmias

Asystole, severe bradycardia and pulseless electrical activity (electromechanical dissociation) are treated with adrenaline (10 µg/kg IV or IO, or 100 µg/kg via the endotracheal tube). Subsequent doses should be the same. Atropine (20 µg/kg IV or IO) and/or pacing may be helpful for asystole or severe bradycardia resistant to ventilation with oxygen and parenteral adrenaline.

Ventricular fibrillation (VF) or pulseless-hypotensive ventricular tachycardia (VT) are treated with a single direct current (DC) shock at 2 J/kg, whether biphasic or monophasic waveform, followed by immediate resumption of chest compressions for 2 minutes. Subsequently, refractory or recurrent VF or VT is treated with single DC shocks at 4 J/kg with intervals of 2 minutes of chest compression. If the onset of VF or VT is witnessed, up to 3 initial stacked shocks (ie, with no intervening chest compression), may be given at doses of 2, 4 and 4 J/kg. DC shock-refractory VF or VT may be treated with amiodarone (5 mg/kg), or less desirably with lignocaine (1 mg/kg), IV or IO.

Although manual defibrillators are preferred, automated external defibrillators delivering about 50 J are suitable for use in children aged 1–8 years. Older children may be treated with adult preset energy levels.

Irrespective of the nature of the pulseless rhythm, adrenaline should be given every 3 minutes at a dose of 10 µg/kg IV or IO, and reversible causes of arrhythmia sought and treated (Figure). Vasopressin offers no advantage over adrenaline. Calcium is not indicated in management of arrhythmias unless caused by hyperkalaemia, calcium channel blocker

toxicity or hypocalcaemia. Sodium bicarbonate may be considered for severe metabolic acidosis or prolonged arrest.

### Pulsatile arrhythmias

Haemodynamically stable VT may be treated with either amiodarone (5 mg/kg over 20–60 minutes) or procainamide (15 mg/kg over 30–60 minutes). Polymorphic pulsatile VT (torsade de pointes) may be treated with magnesium (0.1–0.2 mmol/kg IV or IO).

Haemodynamically stable supraventricular tachycardia (SVT) refractory to vagal stimulation (ice-cold water applied to face, carotid sinus massage, Valsalva manoeuvre) may be treated with adenosine 100 µg/kg (maximum, 6 mg) and then, if needed, 200 µg/kg (maximum, 12 mg). Alternatives are either amiodarone (5 mg/kg over 1 hour followed by 5 µg/kg/min or 25 µg/kg/min for 4 hours followed by 5–15 µg/kg/min) or procainamide (15 mg/kg over 30–60 minutes). Calcium channel blockers should be avoided in infants and used with caution in children. Hypotensive SVT should be treated with DC shock (0.5–1 J/kg monophasic or biphasic). Haemodynamically stable SVT with aberrant conduction resembling VT may be treated as SVT but, if unstable, as VT.

### Post-resuscitation management

Continued mechanical ventilation, inotropic infusion and sometimes renal support may be required for a lengthy period to enable recovery of vital organs. Recovery is usually slow, as cardiorespiratory arrest in children is often secondary to prolonged global hypoxaemia, hypotension, or both. Complications of treatment should be sought.

Glucose levels should be controlled to the normal range. Hyperthermia should be treated vigorously. Therapeutic hypothermia at 32–34°C is often induced for 12–24 hours based on extrapolation from beneficial studies in adults and newborns. This may require muscle relaxation.

In the absence of reversible causes (eg, poisoning, iced-water drowning), prolonged resuscitative efforts in children are unlikely to be successful or to produce a good neurological outcome. Efforts may be discontinued after 20–30 minutes of appropriate advanced cardiopulmonary resuscitation if there is no return of spontaneous circulation.

### Author details

James Tibballs, Chair

Paediatric Advanced Life Support Sub-Committee, Australian Resuscitation Council, Melbourne, VIC.

*Correspondence:* james.tibballs@rch.org.au

□