

Introduction

Changes in paediatric life support guidelines have been partly in response to new scientific evidence, and partly to simplify them in order to assist teaching and retention. As in the past, there remains a paucity of good quality evidence specifically on paediatric resuscitation, and some conclusions have had to be drawn from experimental work or extrapolated from adult data. Cardiorespiratory arrest is much less common in children than in adults and providers who are not specialists in paediatric practice will manage most cases initially. These considerations have emphasised the importance of providing simple, practical guidance, as well as rigorous assessment and incorporation of the best available scientific data.

There remains a strong focus on simplification where possible, based on the knowledge that many children receive no resuscitation at all because rescuers fear doing harm as they have not been taught paediatric resuscitation. Bystander resuscitation significantly improves outcome in children²¹ and there is evidence from experimental models that doing either chest compression or expired air ventilation alone may result in a better outcome than doing nothing. It follows that outcomes could be improved if bystanders who would otherwise do nothing, were encouraged to begin resuscitation, even if they do not follow an algorithm targeted specifically at children. However, there are distinct differences between the arrest of cardiac origin, seen predominately in adults, and the asphyxial arrest, which occurs commonly in children. Therefore, a separate paediatric algorithm is justified for healthcare professionals who have a duty to respond to paediatric emergencies and who are in a position to receive enhanced training.

Guideline changes

Recognition of cardiorespiratory arrest – healthcare provider and lay person

Pulse palpation for 10 s cannot give a reliable measurement of the presence or absence of an effective circulation. This means that palpation of the pulse cannot be the sole determinant of the need for chest compressions. Healthcare providers therefore need to determine the presence or absence of 'signs of life', such as response to stimuli, normal breathing (rather than abnormal gasps) or spontaneous movement. They may also perform pulse palpation but, if there are no other 'signs of life', they should only withhold CPR if they are certain that there is a definite pulse. The decision to start CPR should

take less than 10 s from the time of beginning the initial assessment of the child's circulatory status and if there is still doubt after that time, CPR should be initiated.

If the layperson considers that there are no 'signs of life', CPR should be started immediately.

Compression:Ventilation ratios – healthcare provider and lay person

Although ventilation remains a very important component of CPR in asphyxial arrest, rescuers who are unable or unwilling to provide this should be encouraged to perform at least compression-only CPR. A child is far more likely to be harmed if bystanders do nothing at all.

The CV ratio for resuscitation at birth remains 3:1 but there is uncertainty about the best ratio for use in neonates outside of the delivery room. The 2010 International Consensus on CPR Science²⁷⁰ suggests that the ratio should depend on aetiology but a literal application of this would be complex and confusing to apply in practice. The best approach is for individual units to decide on the CPR teaching that they provide for dealing with neonates based on the likely pathology that they encounter and the type of resuscitation that they perform most commonly.

Chest compression quality

Anthropomorphic and radiographic measurements in children have demonstrated that compression of the chest by one-third the AP diameter is feasible and safe. Data in adults and older children suggest that chest compressions are frequently too shallow, so there has been a subtle, but important, change in the instruction on chest compressions from "approximately one-third" to "at least one-third" of the AP diameter of the chest. A post-mortem review found that physical damage following CPR in children was very rare. It is reasonable to advise, "don't be afraid to push too hard".

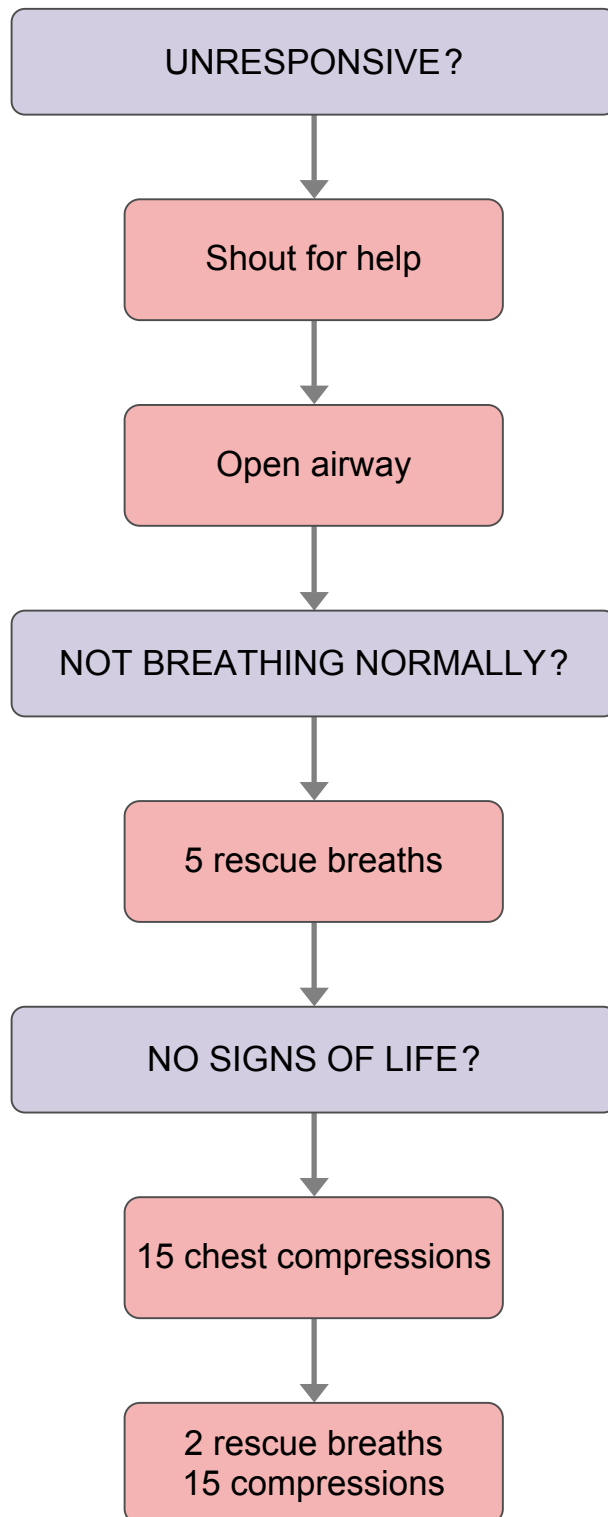
Training and feedback devices are being developed for adults but require absolute, rather than relative, dimensions. In order to facilitate the same for children, the measurement data above indicate that the mean dimensions for one-third compression depths for infants and children are 4 and 5 cm respectively.

In order to be consistent with the adult BLS guidelines the advice on compression rate has been amended to 'at least 100 but not greater than 120 min⁻¹'.

Automated external defibrillators (AEDs) in infants

Although there are only few data, evidence from case reports now favours the use of an AED (preferably with an attenuator) in infants with shockable rhythms, if no manually adjustable machine is available.^{271, 272} Shockable rhythms are unusual in children under 1 year of age and the main focus of resuscitation should be on good-quality CPR.

Paediatric Basic Life Support
(Healthcare professionals with a duty to respond)



Call resuscitation team

Infant and child BLS sequence

Rescuers who have been taught adult BLS, and have no specific knowledge of paediatric resuscitation, should use the adult sequence. The following modifications to the adult sequence will, however, make it more suitable for use in children:

- Give 5 initial rescue breaths before starting chest compression (adult sequence step 5B).
- If you are on your own, perform CPR for 1 min before going for help.
- Compress the chest by at least one-third of its depth. Use two fingers for an infant under 1 year; use one or two hands for a child over 1 year as needed to achieve an adequate depth of compression.

(See adult BLS chapter)

The following is the sequence that should be followed by those with a duty to respond to paediatric emergencies (usually healthcare professional teams):

- 1. Ensure the safety of rescuer and child.**
- 2. Check the child's responsiveness:**
 - Gently stimulate the child and ask loudly, 'Are you all right?'
 - Do not shake infants, or children with suspected cervical spine injuries.
- 3A. If the child responds by answering or moving:**
 - Leave the child in the position in which you find him (provided he is not in further danger).
 - Check his condition and get help if needed.
 - Reassess him regularly.
- 3B. If the child does not respond:**
 - Shout for help.
 - Turn the child onto his back and open the airway using head tilt and chin lift:
 - Place your hand on his forehead and gently tilt his head back.
 - With your fingertip(s) under the point of the child's chin, lift the chin. Do not push on the soft tissues under the chin as this may block the airway.
 - If you still have difficulty in opening the airway, try the jaw thrust method: place the first two fingers of each hand behind each side of the child's mandible (jaw bone) and push the jaw forward.

Have a low threshold for suspecting injury to the neck. If you suspect this, try to open the airway using chin lift or jaw thrust alone. If this is unsuccessful, add head tilt a small

amount at a time until the airway is open. Establishing an open airway takes priority over concerns about the cervical spine.

4. **Keeping the airway open, look, listen, and feel for normal breathing by putting your face close to the child's face and looking along the chest:**
- **Look** for chest movements.
 - **Listen** at the child's nose and mouth for breath sounds.
 - **Feel** for air movement on your cheek.

In the first few minutes after cardiac arrest a child may be taking infrequent, noisy gasps. Do not confuse this with normal breathing. Look, listen, and feel for **no more** than **10 s** before deciding – if you have any doubts whether breathing is normal, act as if it is **not** normal.

5A. If the child is breathing normally:

- Turn the child onto his side into the recovery position (see below).
- Send or go for help – call the relevant emergency number. Only leave the child if no other way of obtaining help is possible.
- Check for continued normal breathing.

5B. If the breathing is not normal or absent:

- Carefully remove any obvious airway obstruction.
- Give 5 initial rescue breaths.
- While performing the rescue breaths note any gag or cough response to your action. These responses, or their absence, will form part of your assessment of 'signs of life', described below.

Rescue breaths for a child over 1 year:

- Ensure head tilt and chin lift.
- Pinch the soft part of his nose closed with the index finger and thumb of your hand on his forehead.
- Open his mouth a little, but maintain the chin lift.
- Take a breath and place your lips around his mouth, making sure that you have a good seal.
- Blow steadily into his mouth over about 1-1.5 s sufficient to make the chest rise visibly.
- Maintaining head tilt and chin lift, take your mouth away and watch for his chest to fall as air comes out.
- Take another breath and repeat this sequence four more times. Identify effectiveness by seeing that the child's chest has risen and fallen in a similar fashion to the movement produced by a normal breath.

Rescue breaths for an infant:

- Ensure a neutral position of the head (as an infant's head is usually flexed when supine, this may require some extension) and apply chin lift.
- Take a breath and cover the mouth and nasal apertures of the infant with your mouth, making sure you have a good seal. If the nose and mouth cannot both be covered in the older infant, the rescuer may attempt to seal only the infant's nose or mouth with his mouth (if the nose is used, close the lips to prevent air escape).
- Blow steadily into the infant's mouth and nose over 1-1.5 s sufficient to make the chest rise visibly.
- Maintain head position and chin lift, take your mouth away, and watch for his chest to fall as air comes out.
- Take another breath and repeat this sequence four more times.

For both infants and children, if you have difficulty achieving an effective breath, the airway may be obstructed:

- Open the child's mouth and remove any visible obstruction. Do not perform a blind finger sweep.
- Ensure that there is adequate head tilt and chin lift but also that the neck is not over extended.
- If head tilt and chin lift has not opened the airway, try the jaw thrust method.
- Make up to 5 attempts to achieve effective breaths. If still unsuccessful, move on to chest compression.

6. Assess the child's circulation (signs of life):

Take no more than 10 s to:

- Look for signs of life. These include any movement, coughing, or normal breathing (not abnormal gasps or infrequent, irregular breaths).
- If you check the pulse **take no more than 10 s**:
 - In a **child aged over 1 year** – feel for the carotid pulse in the neck.
 - In **an infant** – feel for the brachial pulse on the inner aspect of the upper arm.
 - For both infants and children the femoral pulse in the groin (mid way between the anterior superior iliac spine and the symphysis pubis) can also be used.

7A. If you are confident that you can detect signs of a circulation within 10 s:

- Continue rescue breathing, if necessary, until the child starts breathing effectively on his own.
- Turn the child onto his side (into the recovery position) if he starts breathing effectively but remains unconscious.

- Re-assess the child frequently.

7B. If there are no signs of life, unless you are CERTAIN that you can feel a definite pulse of greater than 60 min⁻¹ within 10 s

- Start chest compression.
- Combine rescue breathing and chest compression.

For all children, compress the lower half of the sternum:

- To avoid compressing the upper abdomen, locate the xiphisternum by finding the angle where the lowest ribs join in the middle. Compress the sternum one finger's breadth above this.
- Compression should be sufficient to depress the sternum by at least one-third of the depth of the chest.
- Don't be afraid to push too hard. Push "hard and fast".
- Release the pressure completely, then repeat at a rate of 100 - 120 min⁻¹
- After 15 compressions, tilt the head, lift the chin, and give two effective breaths.
- Continue compressions and breaths in a ratio of 15:2.

The best method for compression varies slightly between infants and children.

Chest compression in infants:

- The lone rescuer should compress the sternum with the tips of two fingers.
- If there are two or more rescuers, use the encircling technique:
 - Place both thumbs flat, side by side, on the lower half of the sternum (as above), with the tips pointing towards the infant's head.
 - Spread the rest of both hands, with the fingers together, to encircle the lower part of the infant's rib cage with the tips of the fingers supporting the infant's back.
 - Press down on the lower sternum with your two thumbs to depress it at least one-third of the depth of the infant's chest.

Chest compression in children aged over 1 year:

- Place the heel of one hand over the lower half of the sternum (as above).
- Lift the fingers to ensure that pressure is not applied over the child's ribs.
- Position yourself vertically above the victim's chest and, with your arm straight, compress the sternum to depress it by at least one-third of the depth of the chest.
- In larger children, or for small rescuers, this may be achieved most easily by using both hands with the fingers interlocked.

8. Continue resuscitation until:

- The child shows signs of life (normal breathing, cough, movement or definite pulse of greater than 60 min⁻¹).
- Further qualified help arrives.
- You become exhausted.

When to call for assistance

It is vital for rescuers to get help as quickly as possible when a child collapses:

- When more than one rescuer is available, one (or more) starts resuscitation while another goes for assistance.
- If only one rescuer is present, undertake resuscitation for about **1 min** before going for assistance. To minimise interruptions in CPR, it may be possible to carry an infant or small child whilst summoning help.
- The only exception to performing 1 min of CPR before going for help is in the case of a child with a **witnessed, sudden** collapse when the rescuer is alone. In this situation, a shockable rhythm is likely and the child may need defibrillation. Seek help immediately if there is no one to go for you.

Recovery position

An unconscious child whose airway is clear and who is breathing normally should be turned onto his side into the recovery position. There are several recovery positions; each has its advocates. The important principles to be followed are:

- The child should be placed in as near a true lateral position as possible with his mouth dependant to enable free drainage of fluid.
- The position should be stable. In an infant, this may require the support of a small pillow or a rolled-up blanket placed behind his back to maintain the position.
- There should be no pressure on the chest that impairs breathing.
- It should be possible to turn the child onto his side and to return him back easily and safely, taking into consideration the possibility of cervical spine injury.
- The airway should be accessible and easily observed.
- The adult recovery position is suitable for use in children.

Explanatory notes

Definitions

- A **newborn** is a child just after birth.
- A **neonate** is a child in the first 28 days of life.
- An **infant** is a child under 1 year.
- A **child** is between 1 year and puberty.

The differences between adult and paediatric resuscitation are largely based on differing aetiology, with primary cardiac arrest being more common in adults whereas children usually suffer from secondary cardiac arrest. The onset of puberty, which is the physiological end of childhood, is the most logical landmark for the upper age limit for use of paediatric guidelines. This has the advantage of being simple to determine in contrast to an age limit, as age may be unknown at the start of resuscitation. Clearly, it is inappropriate and unnecessary to establish the onset of puberty formally; if the rescuer believes the victim to be a child then he should use the paediatric guidelines. If a misjudgment is made, and the victim turns out to be a young adult, little harm will accrue as studies of aetiology have shown that the paediatric pattern of arrest continues into early adulthood.

It is necessary to differentiate between infants and older children, as there are some important differences between these two groups.

Compression:ventilation ratios

The 2010 International Liaison Committee on Resuscitation (ILCOR) Consensus on Science with Treatment Recommendations (CoSTR), continues with the 2005 recommendation that the CV ratio should be based on whether one or more rescuers are present.²⁷¹ The 2010 CoSTR recommends that lay rescuers, who usually learn only single-rescuer techniques, should be taught to use a ratio of 30 compressions to 2 ventilations. This is the same ratio as recommended for adults and enables anyone trained in BLS techniques to resuscitate children with minimal additional information. Two or more rescuers with a duty to respond should learn a ratio with more rescue breaths (15:2), as this has been validated by experimental and mathematical studies.²⁷³²⁷⁴ This latter group, who would normally be healthcare professionals, should receive enhanced training targeted specifically at the resuscitation of children.

Although the 2010 CoSTR recommendation is based on the number of rescuers present, it would certainly negate the main benefit of simplicity if lay rescuers were taught a different ratio for use if there were two of them. Similarly, those with a duty to respond, who would normally be taught to use a ratio of 15:2, do not have to use the 30:2 ratio if they are alone, unless they are not achieving an adequate number of compressions because of difficulty in the transition between ventilation and compression.

Chest compression technique

The 2010 guidelines prioritise chest compressions. Subtle changes in wording (*at least* one-third depth, *at least* 100 min⁻¹) encourage harder and faster compressions. The evidence suggests that rescuers are too gentle and slow and that harm is unlikely, either through the use of excessive force or through performing chest compressions in a victim who has a spontaneous circulation. Interruptions are minimised by not stopping compressions during defibrillator charging, immediate resumption after shock delivery and continuing without a pause for breaths, once the trachea is intubated.

Automated external defibrillators

Since the publication of Guidelines 2005 there have been continuing reports of safe and successful use of AEDs in children less than 8 years and further studies demonstrating that AEDs are capable of identifying arrhythmias accurately in children and are extremely unlikely to advise a shock inappropriately. **Nevertheless, if there is any possibility that an AED may need to be used in children, the purchaser should check that the performance of the particular model has been tested in paediatric arrhythmias.**

Many manufacturers now supply purpose-made paediatric pads or programmes, which typically attenuate the output of the machine to 50-75 J.²⁷⁵ These devices are recommended for children between 1 and 8 years. If no such system or manually adjustable machine is available, an unmodified adult AED may be used.

Although shockable rhythms are extremely unusual in infants, there are rare case reports of the successful use of AEDs in this age group. For an infant in a shockable rhythm, the risk:benefit ratio favours the use of an AED (ideally with an attenuator) if a manually adjustable model is not available.

Choking

Recognition of choking

No new evidence on this subject was presented during the 2010 Consensus Conference. Back blows, chest thrusts and abdominal thrusts all increase intra-thoracic pressure and can expel foreign bodies from the airway. In half of the episodes more than one technique is needed to relieve the obstruction. There are no data to indicate which measure should be used first or in which order they should be applied. If one is unsuccessful, try the others in rotation until the object is cleared.

When a foreign body enters the airway the child reacts immediately by coughing in an attempt to expel it. A spontaneous cough is likely to be more effective and safer than any manoeuvre a rescuer might perform. However, if coughing is absent or ineffective, and the object completely obstructs the airway, the child will become asphyxiated rapidly. Active interventions to relieve choking are therefore required only when

coughing becomes ineffective, but they then must be commenced rapidly and confidently.

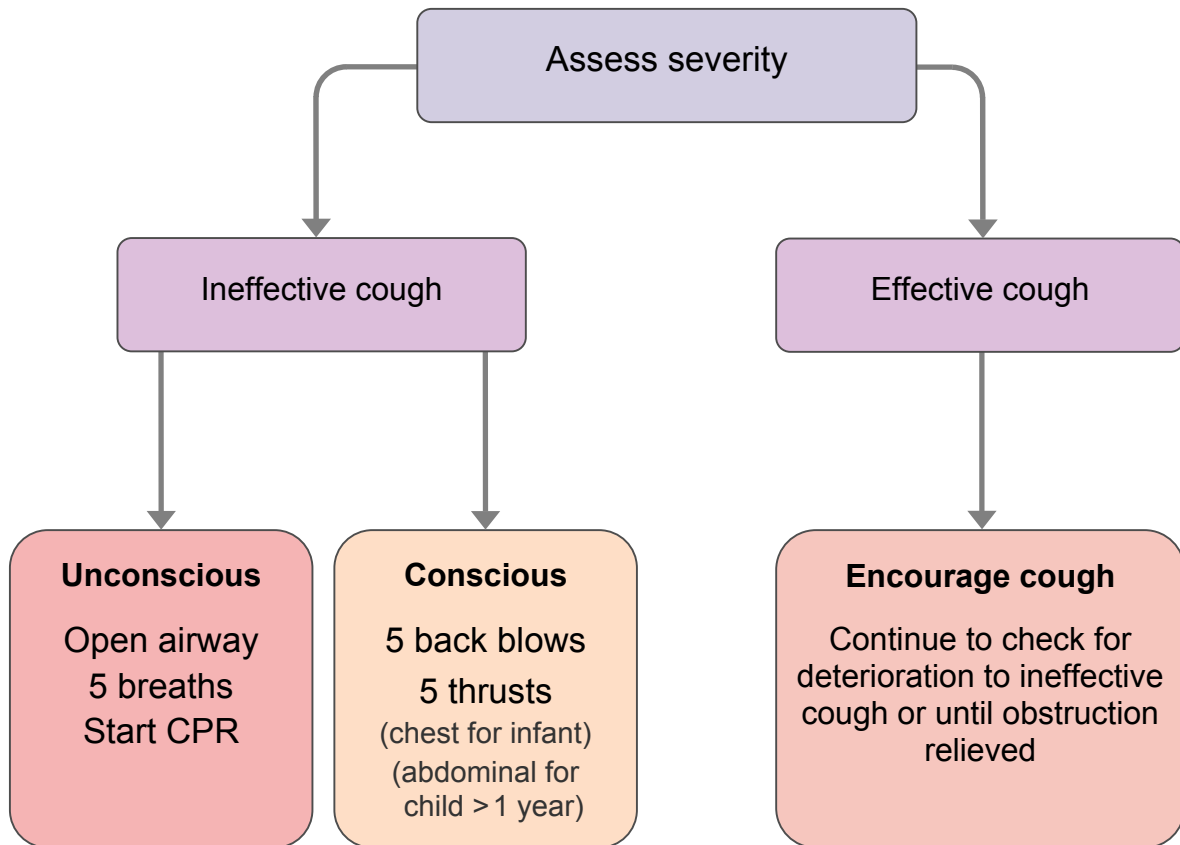
The majority of choking events in children occur during play or whilst eating, when a carer is usually present. Events are therefore frequently witnessed, and interventions are usually initiated when the child is conscious.

Choking is characterised by the sudden onset of respiratory distress associated with coughing, gagging, or stridor. Similar signs and symptoms may also be associated with other causes of airway obstruction, such as laryngitis or epiglottitis, which require different management. Suspect choking caused by a foreign body if:

- the onset was very sudden;
- there are no other signs of illness;
- there are clues to alert the rescuer, for example a history of eating or playing with small items immediately prior to the onset of symptoms.

General signs of choking	
<ul style="list-style-type: none"> • Witnessed episode • Coughing or choking • Sudden onset • Recent history of playing with or eating small objects 	
Ineffective coughing	Effective cough
<ul style="list-style-type: none"> • Unable to vocalise • Quiet or silent cough • Unable to breathe • Cyanosis • Decreasing level of consciousness 	<ul style="list-style-type: none"> • Crying or verbal response to questions • Loud cough • Able to take a breath before coughing • Fully responsive

Paediatric Choking Treatment Algorithm



Relief of choking

Safety and summoning assistance

Safety is paramount. Rescuers should avoid placing themselves in danger and consider the safest action to manage the choking child:

- If the child is coughing effectively, then no external manoeuvre is necessary. Encourage the child to cough, and monitor continuously.
- If the child's coughing is, or is becoming, ineffective, **shout for help** immediately and determine the child's conscious level.

Conscious child with choking

- If the child is still conscious but has absent or ineffective coughing, give back blows.
- If back blows do not relieve choking, give chest thrusts to infants or abdominal thrusts to children. These manoeuvres create an 'artificial cough' to increase intrathoracic pressure and dislodge the foreign body.

Back blows

► In an infant:

- Support the infant in a head-downwards, prone position, to enable gravity to assist removal of the foreign body.
- A seated or kneeling rescuer should be able to support the infant safely across his lap.
- Support the infant's head by placing the thumb of one hand at the angle of the lower jaw, and one or two fingers from the same hand at the same point on the other side of the jaw.
- Do not compress the soft tissues under the infant's jaw, as this will exacerbate the airway obstruction.
- Deliver up to 5 sharp back blows with the heel of one hand in the middle of the back between the shoulder blades.
- The aim is to relieve the obstruction with each blow rather than to give all 5.

► In a child over 1 year:

- Back blows are more effective if the child is positioned head down.
- A small child may be placed across the rescuer's lap as with an infant.
- If this is not possible, support the child in a forward-leaning position and deliver the back blows from behind.

If back blows fail to dislodge the object, and the child is still conscious, use chest thrusts for infants or abdominal thrusts for children. **Do not use abdominal thrusts (Heimlich manoeuvre) for infants.**

Chest thrusts for infants:

- Turn the infant into a head-downwards supine position. This is achieved safely by placing your free arm along the infant's back and encircling the occiput with your hand.
- Support the infant down your arm, which is placed down (or across) your thigh.
- Identify the landmark for chest compression (lower sternum approximately a finger's breadth above the xiphisternum).
- Deliver up to 5 chest thrusts. These are similar to chest compressions, but sharper in nature and delivered at a slower rate.
- The aim is to relieve the obstruction with each thrust rather than to give all 5.

Abdominal thrusts for children over 1 year:

- Stand or kneel behind the child. Place your arms under the child's arms and encircle his torso.
- Clench your fist and place it between the umbilicus and xiphisternum.
- Grasp this hand with your other hand and pull sharply inwards and upwards.
- Repeat up to 4 more times.
- Ensure that pressure is not applied to the xiphoid process or the lower rib cage as this may cause abdominal trauma.
- The aim is to relieve the obstruction with each thrust rather than to give all 5.

Following chest or abdominal thrusts, reassess the child:

- If the object has not been expelled and the victim is still conscious, continue the sequence of back blows and chest (for infant) or abdominal (for children) thrusts.
- Call out, or send, for help if it is still not available.
- Do not leave the child at this stage.

If the object is expelled successfully, assess the child's clinical condition. It is possible that part of the object may remain in the respiratory tract and cause complications. If there is any doubt, seek medical assistance.

Unconscious child with choking

- If the choking child is, or becomes, unconscious place him on a firm, flat surface.
- Call out, or send, for help if it is still not available.
- Do not leave the child at this stage.

Airway opening:

- Open the mouth and look for any obvious object.
- If one is seen, make an attempt to remove it with a single finger sweep.

Do not attempt blind or repeated finger sweeps – these can impact the object more deeply into the pharynx and cause injury.

Rescue breaths:

- Open the airway and attempt 5 rescue breaths.
- Assess the effectiveness of each breath: if a breath does not make the chest rise, reposition the head before making the next attempt.

Chest compression and CPR:

- Attempt 5 rescue breaths and if there is no response, proceed immediately to chest compression regardless of whether the breaths are successful.
- Follow the sequence for single rescuer CPR (step 7B above) for approximately 1 min before summoning the EMS (if this has not already been done by someone else).
- When the airway is opened for attempted delivery of rescue breaths, look to see if the foreign body can be seen in the mouth.
- If an object is seen, attempt to remove it with a single finger sweep.
- If it appears that the obstruction has been relieved, open and check the airway as above. Deliver rescue breaths if the child is not breathing and then assess for signs of life. If there are none, commence chest compressions and perform CPR (step 7B above).
- If the child regains consciousness and is breathing effectively, place him in a safe side-lying (recovery) position and monitor breathing and conscious level whilst awaiting the arrival of the EMS.