RESUSCITATION FROM CARDIAC ARREST: UPDATED GUDIELINES FROM THE RESUSCITATION COUNCIL

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Introduction

Resuscitation from Cardiac Arrest in *Update 10* (1999) described the pathophysiology, aetiology and treatment of cardiac arrest, guided by the Resuscitation Council's guidelines. These guidelines were updated in 2005 by a consensus meeting of the American Heart Association and the International Liaison Committee on Resuscitation. The updates have led to some important changes in patient management.

In addition to subtle differences in the treatment algorithms, several key areas have been identified as 'linking victims with survival':

1. A simplified approach within the guidelines.
2. Early notification of sick and pre-arrest patients to allow pre-emptive treatment.
3. Early chest compressions and a change in compression:ventilation ratio, during cardiopulmonary resuscitation.
4. The introduction of Automated External Defibrillators (AEDs).
5. Mild cooling in the unconscious patient after cardiac arrest, which may improve outcome.

In order to retain detail and ease teaching, the guidelines have been simplified by the generation of a universal algorithm adopted for adult or paediatric life support, at both basic and advanced level. An emphasis is now placed on effective chest compressions rather than rescue breaths at the start of resuscitation and also on a single defibrillation for a shockable rhythm regardless of resultant rhythm. The introduction of a new compression:ventilation ratio aims to minimise interruptions and reduce 'coronary no-flow time'.

Adult Basic Life Support (BLS)

Key changes

- Assume cardiac arrest if patient is unresponsive and apnoeic or has an abnormal breathing pattern. **Give 30 chest compressions immediately**, before any rescue breaths are attempted.
- **For chest compressions, position hands at centre of chest** (no longer measuring 2 finger breadths up from the xiphisternum).
- **Rescue breaths have a shorter duration** – deliver over 1 second (not 2 seconds).

Basic life support is cardio-pulmonary resuscitation (CPR) using no equipment other than a protective oral device. The ratio of compressions to ventilations has changed in order to prevent pauses in the resuscitation process.

Additional changes to Adult BLS:

- **Chest compression only CPR** should be used where the rescuer is not prepared to perform mouth-to-mouth ventilation. In addition, this technique may reduce interruptions in CPR although it is not recommended for out-of-hospital CPR for more than 5 minutes.
- **The central (carotid) pulse check** has been found to be inaccurate in both untrained and healthcare worker rescuers and has been **omitted**. An absence of spontaneous ventilation, including agonal breaths is now taken as a sign of cardiac arrest.

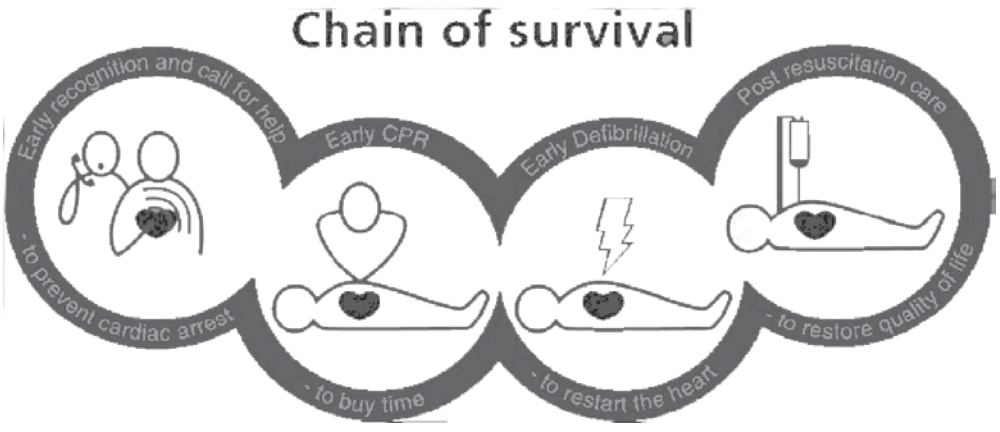
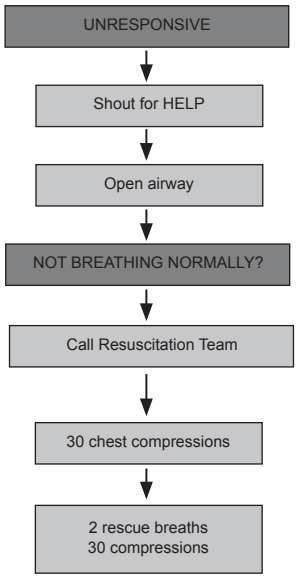


Figure 1: The 'Chain of Survival' emphasises recognition of those at risk of cardiac arrest and calling for appropriate help (first link). The central links focus on cardiopulmonary resuscitation (CPR) and on early defibrillation. The final link is effective post resuscitation care with a particular emphasis placed on the protection of the brain and the heart.

- The person delivering chest compressions should change every 2 minutes with a minimum of delay, so that quality and performance of compressions is maintained.
- If it is obvious the victim has suffered drowning, outcome may be improved by delivering 5 rescue breaths followed by 1 minute of CPR, prior to getting help.

Figure 2: Adult basic Life Support 2005



Prevention of In-Hospital Cardiac Arrest

The primary rhythm for an out-of-hospital cardiac arrest is usually ventricular fibrillation due to ischaemic heart disease, the treatment of which is early defibrillation. In contrast, hospital in-patients often have multi-system abnormalities that are non-cardiac in origin, commonly suffering a gradual deterioration in physiological state, with hypotension, hypoxaemia or both prior to cardiopulmonary arrest. The terminal event in these cases is usually pulseless electrical activity (PEA) or asystole, with less than 20% surviving to go home. Many in-patients suffer a warning 'false cardiac arrest' (a collapse or an apnoeic or unresponsive period), followed by spontaneous recovery. Up to a third of these patients subsequently die in hospital.

Key messages

- Match patients who have a critical illness with appropriate areas of care.
- Regularly record patient's physiological variables on an appropriate record chart that allows frequent observations. Match the frequency of observations with the severity of illness.
- Encourage the recording of **early warning scores** for those patients with critical illness. Ensure that staff receive adequate training in the interpretation of the score and have an identifiable point of contact when help is needed (e.g. **medical emergency team or outreach team**.)

Early warning scores (EWS) involve observation of physiological signs that represent failure of the neurological, cardiovascular and respiratory systems (*Early Warning Scores, Update 17, 2003*). The recorded values are scored according to their deviation from the normal range and the totalled EWS can be used as a trigger to alert staff to deteriorating patients, who may benefit from more intensive medical and nursing therapy.

Some institutions use **medical emergency teams (MET)** to respond to EWS when alerted by ward staff, whereas others have developed **outreach teams**, a concept developed from intensive care nursing to provide management assistance for high-risk ward patients. Theoretically in-hospital mortality, ICU admissions and re-admissions will all be reduced.[1] **Outreach** often involves simple manoeuvres such as prescribing fluids and oxygen, but also provides opportunities for education of ward staff, particularly emphasising the identification and management of the critically ill. ALERT™ (Acute Life Threatening Events - Recognition and Treatment) is an example of a stand-alone course aiming to provide this education to junior nurses and pre-registration doctors in the UK (information available at: www.port.ac.uk/special/alert/).

Similar systems relating physiological disturbance to a score are available for the recognition of sick children eg. Paediatric Early Warning Score (PEWS).

In-Hospital Resuscitation

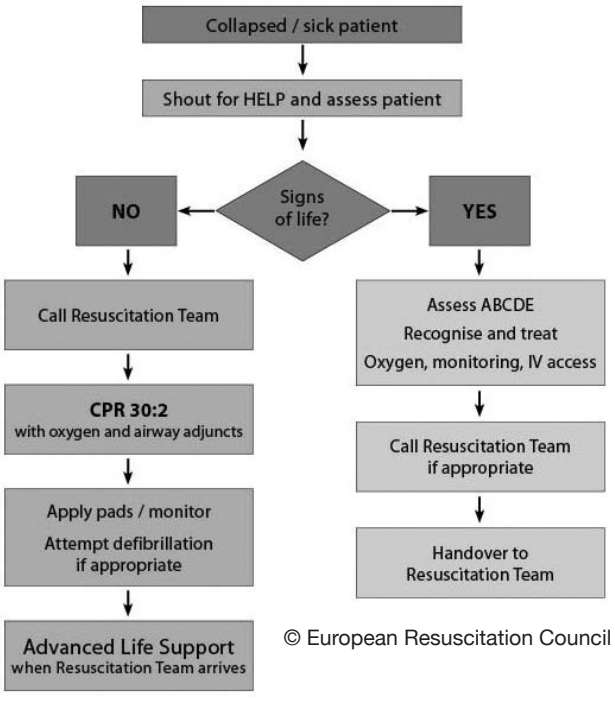


Figure 3: Algorithm for treatment of in-hospital cardiac arrest 2005

Key messages

- Resuscitation in a healthcare setting should encompass both basic and advanced life support algorithms.
- Healthcare workers should all be able to identify a patient with cardiac arrest.
- There should be a common phone number to dial internally to immediately notify of cardiac arrest.
- Simple airway adjuncts (e.g. a pocket mask) and defibrillation should be available within 3 minutes.
- Basic life support with or without defibrillation should be continued until advanced life support providers arrive.

Adult Advanced Life Support (ALS)

These updates are for healthcare workers trained in advanced life support (ALS).

- As with the previous guideline, the treatment pathway is **divided into shockable rhythms** (VF/VT) treated by defibrillation, and non-shockable rhythms (asystole and PEA). Other actions are common to both stems of the algorithm.

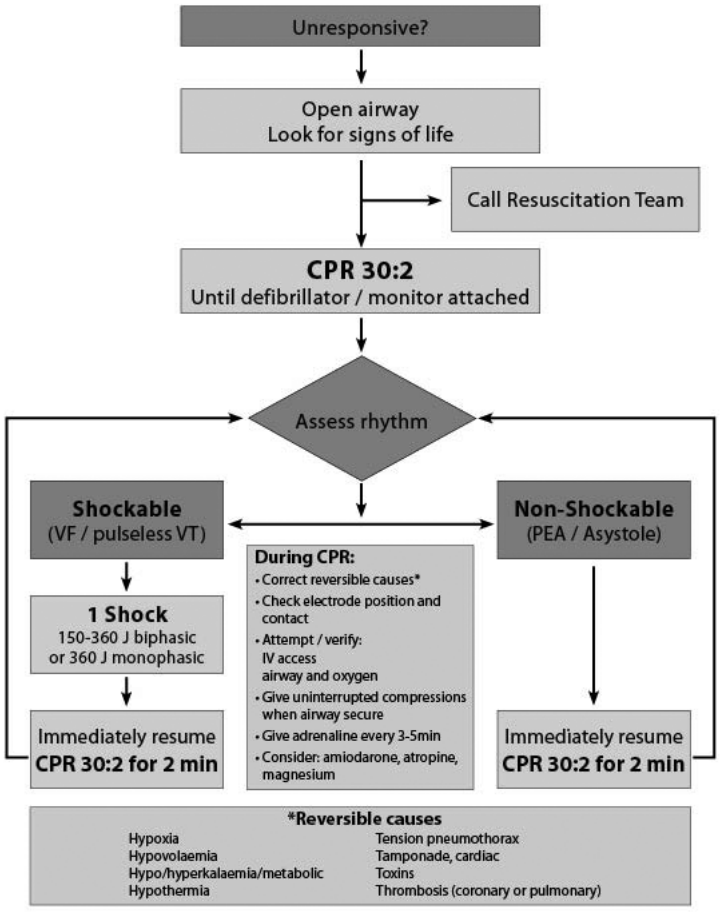


Figure 4: Adult Advanced Life Support 2005

- The **pre-cordial thump** should only be administered by healthcare workers trained in the technique and following a **witnessed, monitored cardiac arrest** where a defibrillator is not immediately to hand. The technique is most effective for VT and should be delivered within 10 seconds.

Key changes to Adult ALS

Defibrillation

- Delays in chest compressions (when analysing the rhythm between shocks or performing ventilations) reduce the chance of converting VF to another rhythm.
- First shock efficacy is much improved with biphasic defibrillators, reducing the need for subsequent shocks. Even if the output is restored post-shock, a period of CPR is believed to encourage myocardial perfusion.
- At an **unwitnessed out-of-hospital** cardiac arrest attended by healthcare workers with manual defibrillators, 2 minutes of CPR (approximately 5 cycles of 30:2) should be given before defibrillation. However, defibrillation should not be delayed if the arrest is witnessed.
- Defibrillation should not be delayed for **in-hospital** cardiac arrest.
- Treat VF or pulseless VT with a single shock followed by resumption of CPR. Reassess rhythm after 2 minutes and give another shock if indicated.
- The initial shock for all **biphasic defibrillators** is 150J (this is a compromise between 120J for rectilinear biphasic waveforms and 150J for truncated exponential waveforms) with subsequent shocks at 200J. The initial and subsequent shocks for **monophasic defibrillators** are now **360J**.
- If there is difficulty differentiating between a rhythm of fine VF and asystole, the treatment should be as for asystole and no shock given. Defibrillation in these cases causes myocardial injury and chest compression is the preferred treatment.
- **Safety aspects**

  - Remove any oxygen source away from the patient by more than 1m during defibrillation, or if the patient is intubated, leave the tracheal tube connected to the oxygen source and stand away.

- Self-adhesive defibrillation pads may be safer than paddles, allowing the operator to stand clear without leaning over the patient. Since they are continuously attached the response time may be quicker.

- The electrode positioned in the axilla should be placed vertically under the clavicle, in the mid axillary line at the level of the female breast or the V6 ECG electrode, but antero-posterior pad placement may be more effective for cardioversion of atrial fibrillation.
- Implantable metal devices such as pacemakers or automated implantable cardiac defibrillators (AICDs) may be damaged in the defibrillation process. Care should be taken to avoid placing pads straight over such devices.

Ventilation

Airway and ventilation management has not changed from the previous resuscitation guidelines:

- In a witnessed cardiac arrest immediate defibrillation is the priority, followed by simple airway manoeuvres as part of BLS.
- Where available, supply oxygen-enriched air. Expired air ventilation only supplies 16-19% oxygen.
- Each breath should last about 1 second and be of sufficient pressure to allow normal chest excursion (and minimise the likelihood of insufflation).
- Alternative airway devices include the Laryngeal Mask Airway (LMA), the proseal LMA, the combitube and the tracheal tube.
  - When using an LMA ventilations may have to be timed with compressions in order to minimise the leak around the cuff.
  - A tracheal tube is the most efficient way to ventilate the lungs and protect against aspiration of gastric contents. However, intubation must be carried out swiftly, without the need to stop chest compressions. Confirmation of correct position of an endotracheal tube is imperative.
- Ventilations should continue at approximately 10 breaths/min. Avoid hyperventilation.

Adrenaline (Epinephrine)

- When commencing ALS for VF/VT, 1mg adrenaline should be given if the VF/VT persists beyond the second cycle of CPR and shock. It is then given every 3-5 minutes.
- For PEA and asystole, give 1mg adrenaline as soon as venous access is established and every 3-5 minutes thereafter (approximately every 2-3 CPR loops).
- Giving adrenaline in doses of 1mg causes massive peripheral vasoconstriction, thereby increasing cerebral and myocardial perfusion. There is no clear evidence that adrenaline reduces mortality. Nevertheless the Consensus recommends that adrenaline is given immediately after confirmation of rhythm and before the shock. Hence the drug-shock-CPR-rhythm check sequence and the adrenaline will be circulated with the chest compressions (this sequence commences after the second shock in ALS for VF/VT).
- Vasopressin is under investigation as an alternative vasopressor.

Rhythm check

Following 2 minutes of CPR the electrical rhythm is assessed.

- If organised complexes are seen but there is no pulse palpable the PEA algorithm is followed.
- If organised complexes are seen during CPR, chest compressions are continued unless signs of life (suggesting a return of spontaneous circulation) are seen. The streamlining of CPR is emphasised to reduce time without chest compressions during shocks and rhythm checks.
- Operators performing chest compressions should be replaced every 2 minutes to maintain efficiency.

PEA and Asystole

Patients with electrical activity but no detectable pulse usually have myocardial contractions of low intensity. Survival is unlikely unless a reversible cause is diagnosed and treated: the four H's and four T's.

Table 1: Reversible causes of Pulseless Electrical Activity (PEA)

Four H's	**Four T's**
Hypoxia	Tension pneumothorax
Hypothermia	Toxic disturbance
Hyperkalaemia, Hypokalaemia, Hypocalcaemia, acidosis and other metabolic disturbances	Thromboembolism particularly pulmonary embolism – on-going CPR is not a contraindication to thrombolysis, which should be considered
Hypovolaemia	Tamponade (cardiac)

- For asystole and slow PEA (<60bpm) 3mg of atropine is given to provide maximal vagal blockade.

Anti-arrhythmic drugs

- If VF/VT persists past 3 shocks, where available 300mg of amiodarone is given by bolus injection. A further 150mg can be given for persistent or

refractory VF/VT, followed by 900mg amiodarone over 24 hours. There is no evidence that use of amiodarone improves survival to hospital discharge.

- If amiodarone is unavailable, lignocaine can be used at a dose of 1mg/kg. It should not be used with amiodarone.

Peri-Arrest Arrhythmias

The principles of treatment for peri-arrest arrhythmias remain similar to previous guidelines. The bradycardia algorithm is almost unchanged and the three separate algorithms for broad-complex, narrow-complex and atrial fibrillation have been streamlined into one algorithm sharing common treatment principles.

Key messages: Peri-arrest arrhythmias

- The presence of **adverse signs** determines treatment options: clinical evidence of low cardiac output (eg BP<90mmHg), excessive tachycardia (>150bpm) or bradycardia (<40bpm), heart failure or chest pain.
- Treatment options are **anti-arrhythmic drugs**, electrical cardioversion and **cardiac pacing**.
- If adverse signs are present with bradycardia, give atropine 500mcg IV and repeat every 3-5min up to 3mg.
- If adverse signs are present with tachycardia, attempt synchronised cardioversion immediately. For broad-complex tachycardia or atrial fibrillation start at 120-150J **biphasic shock** (200J monophasic) and increase in increments if unsuccessful. Narrow complex tachycardias and atrial flutter often revert at lower energy, start at 70-120J biphasic (100J monophasic).
- A regular broad complex tachycardia in a stable patient should be treated with amiodarone 300mg intravenously over 20-60min, followed by an infusion of 900mg over 24hr.
- A regular narrow complex tachycardia in a stable patient should be treated with vagal manoeuvres (this terminates up to a quarter of episodes of paroxysmal SVT). If the arrhythmia persists, treat with 6mg adenosine as a bolus. If there is no response, give 12mg of adenosine and one further 12mg bolus if needed. If this is unsuccessful, verapamil 2.5mg-5mg can be given over 2min.
- An irregular narrow complex tachycardia is likely to be AF. Patients who have been in AF less than 48hrs can be cardioverted (electrically or chemically). For those who have been in AF more than 48hrs, the risk of atrial thrombus is higher and they should not be treated by cardioversion until **fully anti-coagulated** for 3 weeks or mural thrombus within the heart has been excluded. Where available this requires transoesophageal echocardiography.

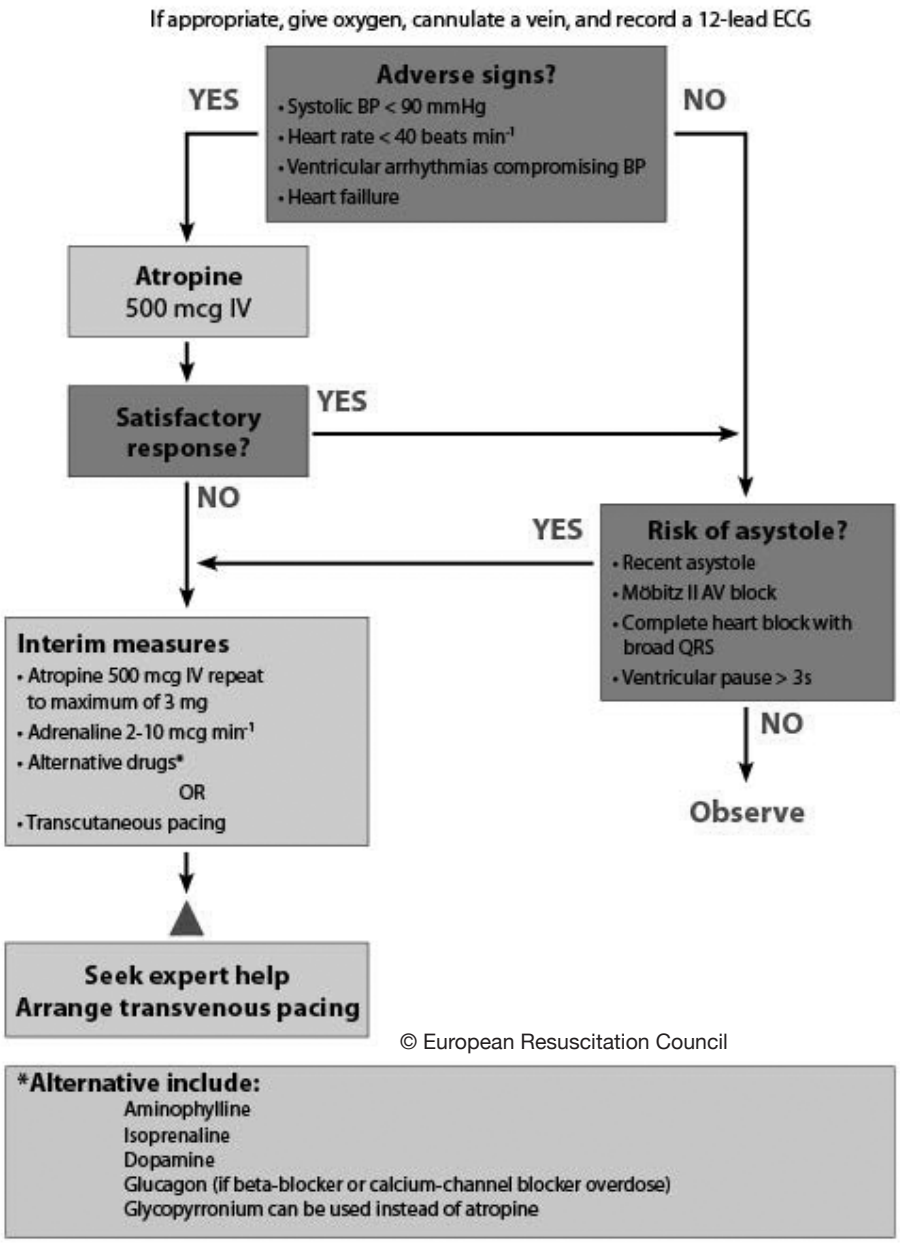


Figure 5: Algorithm for treatment of peri-arrest bradycardia

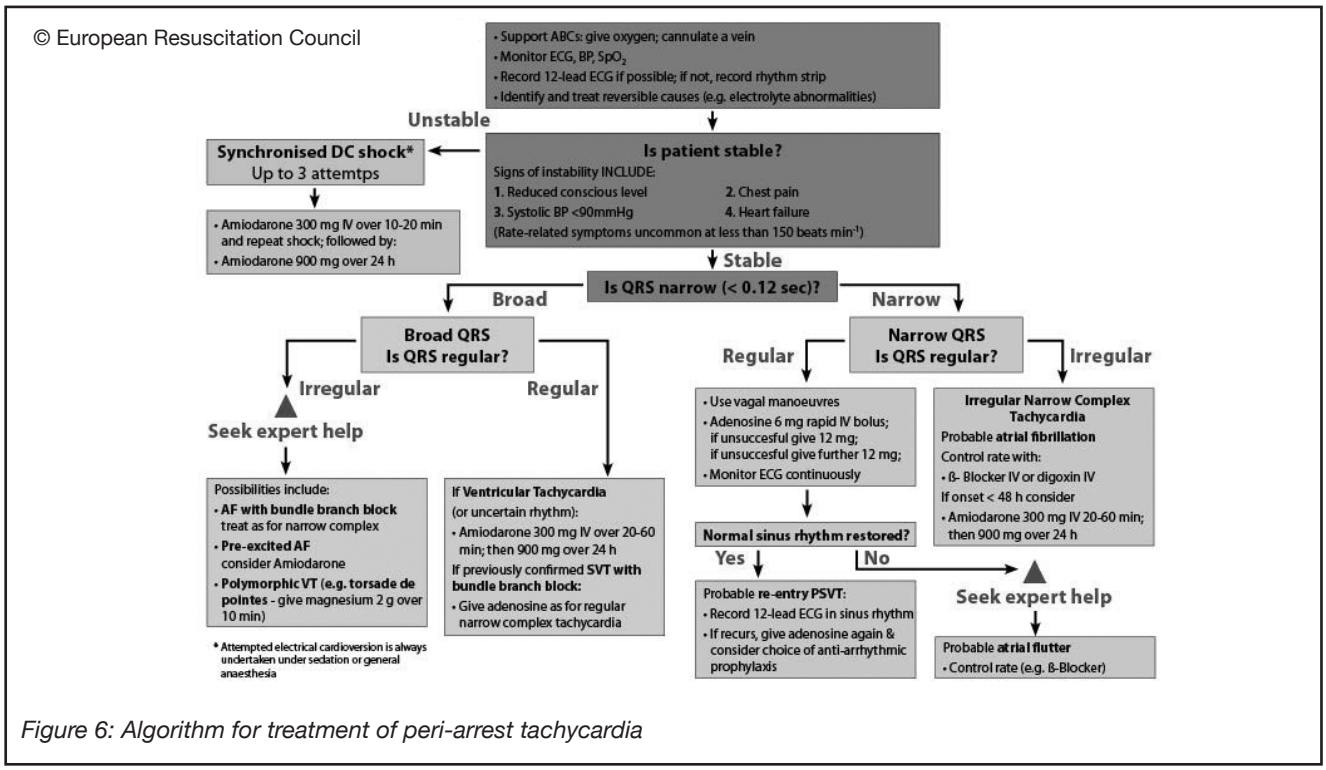


Figure 6: Algorithm for treatment of peri-arrest tachycardia

Post-resuscitation care

- Evidence from two studies suggests that patients who suffer an out-of-hospital VF cardiac arrest, who have a return of circulation, but remain unconscious, should be cooled to 32-34°C (moderate hypothermia) for 12-24hrs.[2,3]
- Mild hypothermia may also benefit patients who have spontaneous return of circulation but remain unconscious after suffering an in-hospital cardiac arrest or after a non-VF arrest out-of-hospital.[4]

Automated External Defibrillators (AEDs)

Although not available in all countries, the use of automated external defibrillators has been integrated into the basic life support guidelines. In many countries AEDs have become more widespread in public locations and healthcare institutions. AEDs function with a voice prompt to guide the user and this function can be programmable. All AEDs analyse the cardiac rhythm and the verbal prompts usually give advice for one of 4 options:

1. A shock for a shockable rhythm.
2. A reminder to omit the check pulse, breathing or rhythm after a shock.
3. Immediate resumption of CPR after a shock.
4. A voice prompt to assess rhythm and pulse after 2 minutes.

Fully automatic AEDs give the shocks automatically after a voice prompt, whereas semi-automatic AEDs require the operator to execute the shock after a voice prompt. Again, the emphasis is on streamlining the resuscitation process and minimising pauses between shocks.

The use of AEDs for cardiac arrest in the public domain (e.g. at airports) has been shown to increase survival when the response time for defibrillation is less than 6 minutes. In crowded places this is often achievable since the collapse is usually witnessed. Longer delays than this do not produce such good survival rates.

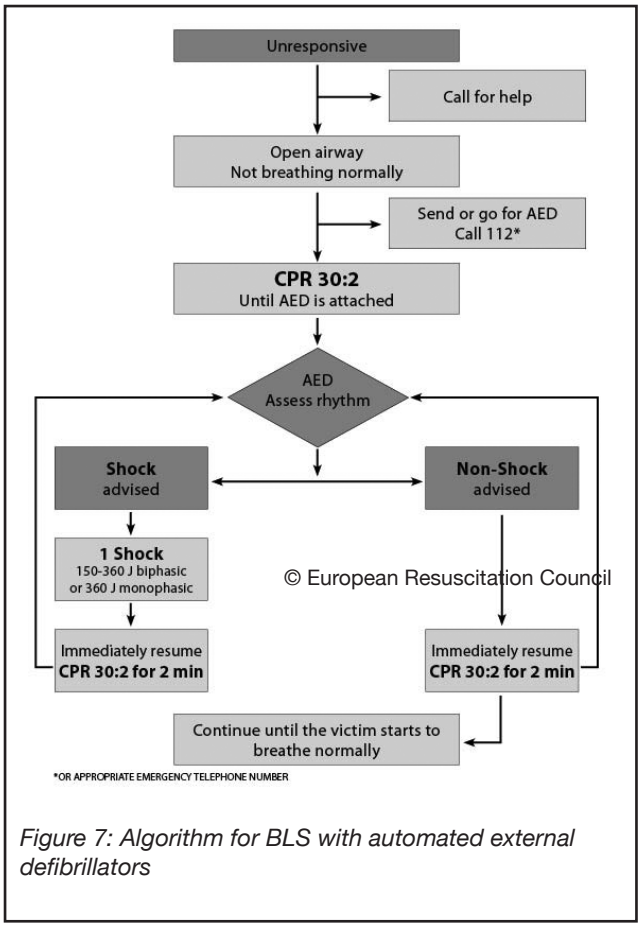


Figure 7: Algorithm for BLS with automated external defibrillators

Guidelines for AED use:

- The shock sequence is as per non-AED - there are no changes to the sequence of actions in operating the AED. The single shock should be immediately followed by CPR.
- CPR should be continued during application of pads.
- The axillary pad should be applied vertically to improve efficiency.

Issues concerning ongoing training, maintenance and audit need to be considered for AEDs used in public areas, since the average number of cardiac arrests is only 2 per year in each location. Most cardiac arrests occur in residential settings where the scenario is best serviced by fast response medical-trained personnel.

The algorithm emphasises early chest compressions until an AED arrives, and then defibrillation as soon as possible regardless of the place in the BLS algorithm. The chance of successful defibrillation decreases 7-10% with each minute of delay, but BLS does help to maintain a shockable rhythm in the short term.

AEDs are designed for use in adults and children above 8yrs, and are not recommended for use in children under 1 year. Paediatric pads are available for younger children with a specific paediatric mode.

Paediatric Basic Life Support

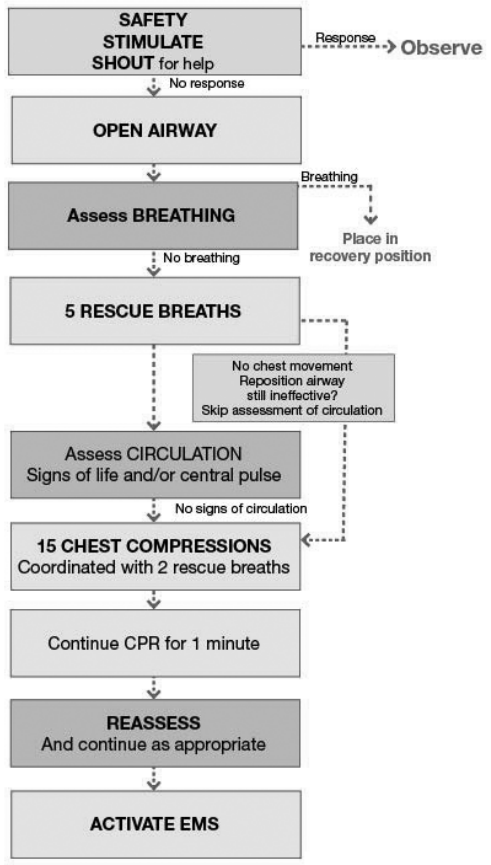


Figure 8 Algorithm for Paediatric BLS

Key change: Paediatric BLS

- Lay rescuers should use a ratio of 30 compressions to 2 ventilations. Two or more rescuers with specific specialist training in resuscitation should use a ratio of 15 compressions to 2 ventilations.
- Compression rate is 100 per minute.

Most changes in the paediatric guidelines have been made to simplify and minimise differences between adult and paediatric protocols, to aid teaching and retention of knowledge. Slight modification in children includes:

- 5 rescue breaths prior to compressions.
- Continue CPR for 1 minute before going for help if you are a lone rescuer, unless the collapse was witnessed, in which case seek help immediately.
- Compress the chest by a third of the depth of the chest.
- 2 fingers are used for compressions in infants (less than 2yr) and 1 or 2 hands for older children as needed for adequate compression depth.
- The treatment of foreign body airway obstruction is unchanged from previous guidelines.

Paediatric Advanced Life Support

Drug Administration

- Drugs should be given intravascularly (intravenous or intraosseous) where possible. When administered by the tracheal route, the low plasma concentration of adrenaline may cause detrimental hypotension via transient beta-adrenergic effects.
- The dose of adrenaline is 10mcg/kg **on each occasion** in cardiac arrest. No benefit has been shown using higher dose adrenaline (100mcg/kg).

Ventilation

- Cuffed tracheal tubes are as safe as uncuffed tubes for infants and children but not newborns. Care must be taken to monitor inflation cuff pressure and verify tube position.

Defibrillation

- One defibrillating shock, as per adult algorithm, is recommended for VF/VT rather than 3 stacked shocks. There is a high rate of success for first shock conversion of VF and it is thought to be detrimental to interrupt cardiac compressions.
- The recommended shock energy is **4J/kg**. Case reports suggest that shock levels of 2J/kg may be adequate but 4J/kg probably causes less myocardial damage than in adult hearts.
- AEDs - A standard AED can be used for children over 8yrs. An attenuated program or paediatric pads should be used for children under 8 years. If these are not available an unmodified AED may be used down to 1 year. Manual defibrillation must

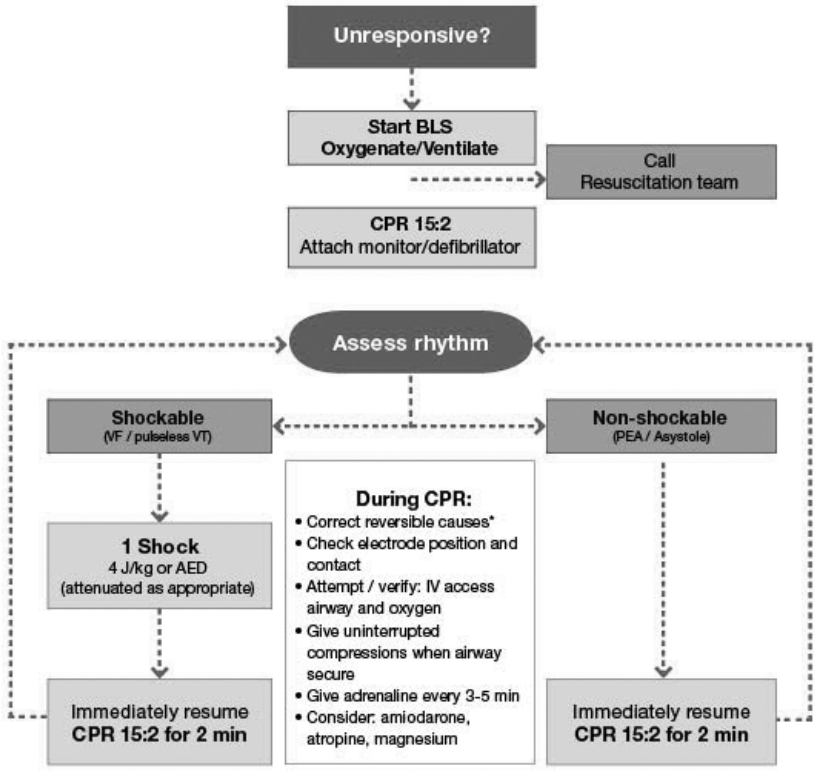


Figure 9: Algorithm for Paediatric Advanced Life Support

Newborn Life Support

Key change: Newborn Life Support

- Attempts to aspirate meconium from the mouth and nose of the unborn baby, while the head is on the perineum, **are no longer recommended**.
- Initial ventilatory assistance may be with air. This should be supplemented with oxygen if there is no prompt improvement.
- Adrenaline should be given by intravenous or intraosseous route. Administration via an endo-tracheal tube is unlikely to be effective.

be available for infants.

Initial Action

- Ensure the cord is clamped and the baby is covered with dry towels, this can often provide significant stimulation for spontaneous respiration. If preterm (<30weeks), the baby should be placed under a radiant heater or the body and head covered in food-grade plastic wrapping without drying first.
- The heart rate is best assessed by auscultation with a stethoscope or palpating the umbilical cord. Normal heart beat of a new born healthy baby is **120-150 beats/min**.

Airway and breathing

- The airway is best managed with the head in the neutral position. A chin lift or jaw thrust can help.
- Give **5 inflation breaths** if there is no adequate breathing after 90 seconds. The baby's lungs may be filled with fluid. Most babies needing help respond to successful lung inflation.

Chest compressions

- The most effective method is an encircling technique with the thumbs joining just below the inter-nipple line. Compress the chest by approximately **one third the chest depth at a ratio of 3:1 (compressions:ventilations)**.

Drugs

- If there is still no effective cardiac output adrenaline is given at a dose of **10mcg/kg** (0.1ml/kg of 1:10 000 solution). A dose up to **30mcg/kg** may be tried if this is ineffective (0.3ml/kg of 1:10 000 solution).
- Sodium bicarbonate at a dose of 2 to 4ml/kg of 4.2% bicarbonate solution can be given (1 to 2mmol of bicarbonate/kg). The recommended dose of glucose is 250 mg/kg (2.5ml/kg of 10% glucose).

The full European Resuscitation Council guidelines can be found at:

www.erc.edu/index.php/guidelines_download_2005/en/

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