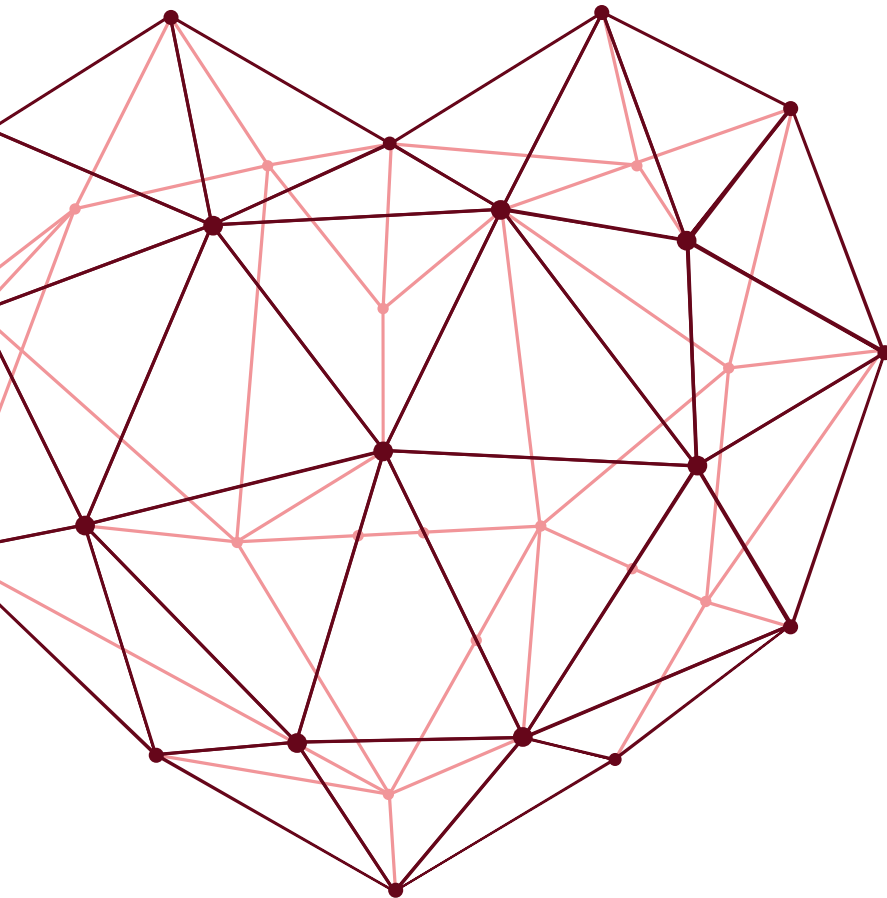




Summary of the main changes in the Resuscitation Guidelines

ERC GUIDELINES 2015



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Summary of the changes since the 2010 Guidelines

Adult basic life support and automated external defibrillation

- The ERC Guidelines 2015 highlight the critical importance of the interactions between the emergency medical dispatcher, the bystander who provides CPR and the timely deployment of an AED. An effective, co-ordinated community response that draws these elements together is key to improving survival from out-of-hospital cardiac arrest.
- The emergency medical dispatcher plays an important role in the early diagnosis of cardiac arrest, the provision of dispatcher-assisted CPR (also known as telephone CPR), and the location and dispatch of an AED.
- The bystander who is trained and able should assess the collapsed victim rapidly to determine if the victim is unresponsive and not breathing normally and then immediately alert the emergency services.
- The victim who is unresponsive and not breathing normally is in cardiac arrest and requires CPR. Bystanders and emergency medical dispatchers should be suspicious of cardiac arrest in any patient presenting with seizures and should carefully assess whether the victim is breathing normally.
- CPR providers should perform chest compressions for all victims in cardiac arrest. CPR providers trained and able to perform rescue breaths should combine chest compressions and rescue breaths. Our confidence in the equivalence between chest compression-only and standard CPR is not sufficient to change current practice.
- High-quality CPR remains essential to improving outcomes. The guidelines on compression depth and rate have not changed. CPR providers should ensure chest compressions of adequate depth (at least 5 cm but no more than 6 cm) with a rate of 100–120 compressions min^{-1} . After each compression allow the chest to recoil completely and minimise interruptions in compressions. When providing rescue breaths/ventilations spend approximately 1 s inflating the chest with sufficient volume to ensure the chest rises visibly. The ratio of chest compressions to ventilations remains 30:2. Do not interrupt chest compressions for more than 10 s to provide ventilations.
- Defibrillation within 3-5 min of collapse can produce survival rates as high as 50-70 %. Early defibrillation can be achieved through CPR providers using public access and on-site AEDs. Public access AED programmes should be actively implemented in public places that have a high density of citizens.
- The adult CPR sequence can be used safely in children who are unresponsive and not breathing normally. Chest compression depths in children should be at least one third of the depth of the chest (for infants that is 4 cm, for children 5 cm).

- A foreign body causing severe airway obstruction is a medical emergency and requires prompt treatment with back blows and, if that fails to relieve the obstruction, abdominal thrusts. If the victim becomes unresponsive CPR should be started immediately whilst help is summoned.

Adult advanced life support

The ERC 2015 ALS Guidelines emphasise improved care and implementation of the guidelines in order to improve patient focused outcomes. The key changes since 2010 are:

- Continued emphasis on the use of rapid response systems for care of the deteriorating patient and prevention of in-hospital cardiac arrest.
- Continued emphasis on minimally interrupted high-quality chest compressions throughout any ALS intervention: chest compressions are paused briefly only to enable specific interventions. This includes minimising interruptions in chest compressions for less than 5 s to attempt defibrillation.
- Keeping the focus on the use of self-adhesive pads for defibrillation and a defibrillation strategy to minimise the preshock pause, although we recognise that defibrillator paddles are used in some settings.
- There is a new section on monitoring during ALS with an increased emphasis on the use of waveform capnography to confirm and continually monitor tracheal tube placement, quality of CPR and to provide an early indication of return of spontaneous circulation (ROSC).
- There are a variety of approaches to airway management during CPR and a stepwise approach based on patient factors and the skills of the rescuer is recommended.
- The recommendations for drug therapy during CPR have not changed, but there is greater equipoise concerning the role of drugs in improving outcomes from cardiac arrest.
- The routine use of mechanical chest compression devices is not recommended, but they are a reasonable alternative in situations where sustained high-quality manual chest compressions are impractical or compromise provider safety.
- Peri-arrest ultrasound may have a role in identifying reversible causes of cardiac arrest.
- Extracorporeal life support techniques may have a role as a rescue therapy in selected patients where standard ALS measures are not successful.

Cardiac arrest in special circumstances

Special causes

This section has been structured to cover the potentially reversible causes of cardiac arrest that must be identified or excluded during any resuscitation. They are divided into two groups of four - 4Hs and 4Ts: hypoxia; hypo-/hyperkalaemia, and other electrolyte disorders; hypo-/hyperthermia; hypovolaemia; tension pneumothorax; tamponade (cardiac); thrombosis (coronary and pulmonary); toxins (poisoning).

- Survival after an asphyxia-induced cardiac arrest is rare and survivors usually have severe neurological impairment. During CPR, early effective ventilation of the lungs with supplementary oxygen is essential.
- A high degree of clinical suspicion and aggressive treatment can prevent cardiac arrest from electrolyte abnormalities. The new algorithm provides clinical guidance to emergency treatment of life-threatening hyperkalaemia.
- Hypothermic patients without signs of cardiac instability can be rewarmed externally using minimally invasive techniques. Patients with signs of cardiac instability should be transferred directly to a centre capable of extracorporeal life support (ECLS).
- Early recognition and immediate treatment with intramuscular adrenaline remains the mainstay of emergency treatment for anaphylaxis.
- A new treatment algorithm for traumatic cardiac arrest was developed to prioritise the sequence of life-saving measures.
- Transport with continuing CPR may be beneficial in selected patients where there is immediate hospital access to the catheterisation laboratory and experience in percutaneous coronary intervention (PCI) with ongoing CPR.
- Recommendations for administration of fibrinolytics when pulmonary embolism is the suspected cause of cardiac arrest remain unchanged.

Special environments

The special environments section includes recommendations for the treatment of cardiac arrest occurring in specific locations. These locations are specialised healthcare facilities (e.g. operating theatre, cardiac surgery, catheterisation laboratory, dialysis unit, dental surgery), commercial airplanes or air ambulances, field of play, outside environment (e.g. drowning, difficult terrain, high altitude, avalanche burial, lightning strike and electrical injuries) or the scene of a mass casualty incident.

- A new section covers the common causes and relevant modification to resuscitative procedures in patients undergoing surgery.
- In patients following major cardiac surgery, key to successful resuscitation is recognising the need to perform immediate emergency resternotomy, especially in the context of tamponade or haemorrhage, where external chest compressions may be ineffective.
- Cardiac arrest from shockable rhythms (ventricular fibrillation (VF) or pulseless ventricular tachycardia (pVT) during cardiac catheterisation should immediately be treated with up to three stacked shocks before starting chest compressions. Use of mechanical chest compression devices during angiography is recommended to ensure high-quality chest compressions and to reduce the radiation burden to personnel during angiography with ongoing CPR.
- AEDs and appropriate CPR equipment should be mandatory on board of all commercial aircraft in Europe, including regional and low-cost carriers. Consider an over-the-head technique of CPR if restricted access precludes a conventional method.
- Sudden and unexpected collapse of an athlete on the field of play is likely to be cardiac in origin and requires rapid recognition and early defibrillation.

- Submersion exceeding 10 min is associated with poor outcome. Bystanders play a critical role in early rescue and resuscitation. Resuscitation strategies for those in respiratory or cardiac arrest continue to prioritise oxygenation and ventilation.
- The chances of good outcome from cardiac arrest in difficult terrain or mountains may be reduced because of delayed access and prolonged transport. There is a recognised role of air rescue and availability of AEDs in remote but often-visited locations.
- The cut-off criteria for prolonged CPR and extracorporeal rewarming of avalanche victims in cardiac arrest have become more stringent to reduce the number of futile cases treated with extracorporeal life support (ECLS).
- Safety measures are emphasised when providing CPR to the victim of an electrical injury.
- During mass casualty incidents (MCIs), if the number of casualties overwhelms healthcare resources, withhold CPR for those without signs of life.

Special patients

The section on special patients gives guidance for CPR in patients with severe comorbidities (asthma, heart failure with ventricular assist devices, neurological disease, obesity) and those with specific physiological conditions (pregnancy, elderly people).

- In patients with ventricular assist devices (VADs), confirmation of cardiac arrest may be difficult. If during the first 10 days after surgery, cardiac arrest does not respond to defibrillation, perform resternotomy immediately.
- Patients with subarachnoid haemorrhage may have ECG changes that suggest an acute coronary syndrome (ACS). Whether a computed tomography (CT) brain scan is done before or after coronary angiography will depend on clinical judgement.
- No changes to the sequence of actions are recommended in resuscitation of obese patients, but delivery of effective CPR may be challenging. Consider changing rescuers more frequently than the standard 2-min interval. Early tracheal intubation is recommended.
- For the pregnant woman in cardiac arrest, high-quality CPR with manual uterine displacement, early ALS and delivery of the foetus if early return of spontaneous circulation (ROSC) is not achieved remain key interventions.

Post-resuscitation care

This section is new to the European Resuscitation Council Guidelines; in 2010 the topic was incorporated into the section on ALS. The ERC has collaborated with the European Society of Intensive Care Medicine to produce these post-resuscitation care guidelines, which recognise the importance of high-quality post-resuscitation care as a vital link in the Chain of Survival.

The most important changes in post-resuscitation care since 2010 include:

- There is a greater emphasis on the need for urgent coronary catheterisation and percutaneous coronary intervention (PCI) following out-of-hospital cardiac arrest of likely cardiac cause.

- Targeted temperature management remains important but there is now an option to target a temperature of 36°
- C instead of the previously recommended 32–34°C. The prevention of fever remains very important.
- Prognostication is now undertaken using a multimodal strategy and there is emphasis on allowing sufficient time for neurological recovery and to enable sedatives to be cleared.
- A novel section has been added which addresses rehabilitation after survival from a cardiac arrest. Recommendations include the systematic organisation of follow-up care, which should include screening for potential cognitive and emotional impairments and provision of information.

Paediatric life support

Guideline changes have been made in response to convincing new scientific evidence and, by using clinical, organisational and educational findings, they have been adapted to promote their use and ease for teaching.

Basic life support

- The duration of delivering a breath is about 1 s, to coincide with adult practice.
- For chest compressions, the lower sternum should be depressed by at least one third the anterior-posterior diameter of the chest (4 cm for the infant and 5 cm for the child).

Managing the seriously ill child

- If there are no signs of septic shock, then children with a febrile illness should receive fluid with caution and reassessment following its administration. In some forms of septic shock, restricting fluids with isotonic crystalloid may be of benefit as compared to liberal use of fluids.
- For cardioversion of a supraventricular tachycardia (SVT), the initial dose has been revised to 1 J kg⁻¹.

Paediatric cardiac arrest algorithm

- Many of the features are common with adult practice.

Post-resuscitation care

- Prevent fever in children who have return of spontaneous circulation (ROSC) from an out-of-hospital setting.
- Targeted temperature management of children post-ROSC should be either normothermia or mild hypothermia.
- There is no single predictor for when to stop resuscitation.

Resuscitation and support of transition of babies at birth

The following are the main changes that have been made to the ERC guidelines for resuscitation at birth in 2015:

- **Support of transition:** Recognising the unique situation of the baby at birth, who rarely requires resuscitation but sometimes needs medical help during the process of postnatal transition. The term support of transition has been introduced to better distinguish between interventions that are needed to restore vital organ functions (resuscitation) or to support transition.
- **Cord clamping:** For uncompromised babies, a delay in cord clamping of at least 1 min from the complete delivery of the infant, is now recommended for term and preterm babies. As yet there is insufficient evidence to recommend an appropriate time for clamping the cord in babies who require resuscitation at birth.
- **Temperature:** The temperature of newly born non-asphyxiated infants should be maintained between 36.5°C and 37.5°C after birth. The importance of achieving this has been highlighted and reinforced because of the strong association with mortality and morbidity. The admission temperature should be recorded as a predictor of outcome as well as a quality indicator.
- **Maintenance of temperature:** At < 32 weeks gestation, a combination of interventions may be required in addition to maintain the temperature between 36.5°C and 37.5°C after delivery through admission and stabilisation. These may include warmed humidified respiratory gases, increased room temperature plus plastic wrapping of body and head, plus thermal mattress or a thermal mattress alone, all of which have been effective in reducing hypothermia.
- **Optimal assessment of heart rate:** It is suggested in babies requiring resuscitation that the ECG can be used to provide a rapid and accurate estimation of heart rate.
- **Meconium:** Tracheal intubation should not be routine in the presence of meconium and should only be performed for suspected tracheal obstruction. The emphasis should be on initiating ventilation within the first minute of life in non-breathing or ineffectively breathing infants and this should not be delayed.
- **Air/oxygen:** Ventilatory support of term infants should start with air. For preterm infants, either air or a low concentration of oxygen (up to 30 %) should be used initially. If, despite effective ventilation, oxygenation (ideally guided by oximetry) remains unacceptable, use of a higher concentration of oxygen should be considered.
- **CPAP:** Initial respiratory support of spontaneously breathing preterm infants with respiratory distress may be provided by CPAP rather than intubation.

Acute coronary syndromes

The following is a summary of the most important new views and changes in recommendations for the diagnosis and treatment of acute coronary syndromes (ACS).

Diagnostic Interventions in ACS

- Pre-hospital recording of a 12-lead electrocardiogram (ECG) is recommended in patients with suspected ST segment elevation acute myocardial infarction (STEMI). For those with STEMI this expedites pre-hospital and in-hospital reperfusion and reduces mortality.
- Non-physician ECG STEMI interpretation with or without the aid of computer ECG STEMI interpretation is suggested if adequate diagnostic performance can be maintained through carefully monitored quality assurance programmes.
- Pre-hospital STEMI activation of the catheterisation laboratory may not only reduce treatment delays but may also reduce patient mortality.
- The use of negative high-sensitivity cardiac troponins (hs-cTn) during initial patient evaluation cannot be used as a standalone measure to exclude an ACS, but in patients with very low risk scores may justify early discharge.

Therapeutic Interventions in ACS

- Adenosine diphosphate (ADP) receptor antagonists (clopidogrel, ticagrelor, or prasugrel-with specific restriction), may be given either pre-hospital or in the ED for STEMI patients planned for primary PCI.
- Unfractionated heparin (UFH) can be administered either in the pre-hospital or in-hospital setting in patients with STEMI and a planned primary PCI approach.
- Pre-hospital enoxaparin may be used as an alternative to pre-hospital UFH for STEMI.
- Patients with acute chest pain with presumed ACS do not need supplemental oxygen unless they present with signs of hypoxia, dyspnoea, or heart failure.

Reperfusion decisions in STEMI

Reperfusion decisions have been reviewed in a variety of possible local situations.

- When fibrinolysis is the planned treatment strategy, we recommend using pre-hospital fibrinolysis in comparison to in-hospital fibrinolysis for STEMI where transport times are > 30 min and pre-hospital personnel are well trained.
- In geographic regions where PCI facilities exist and are available, direct triage and transport for PCI is preferred to pre-hospital fibrinolysis for STEMI.
- Patients presenting with STEMI in the emergency department (ED) of a non-PCI capable hospital should be transported immediately to a PCI centre provided that treatment delays for PPCI are less than 120 min (60-90 min for early presenters and those with extended infarctions), otherwise patients should receive fibrinolysis and be transported to a PCI centre.

- Patients who receive fibrinolytic therapy in the emergency department of a non-PCI centre should be transported if possible for early routine angiography (within 3-24 h from fibrinolytic therapy) rather than be transported only if indicated by the presence of ischaemia.
- PCI in less than 3 h following administration of fibrinolytics is not recommended and can be performed only in case of failed fibrinolysis.

Hospital reperfusion decisions after return of spontaneous circulation

- We recommend emergency cardiac catheterisation lab evaluation (and immediate PCI if required), in a manner similar to patients with STEMI without cardiac arrest, in selected adult patients with ROSC after out-of-hospital cardiac arrest (OHCA) of suspected cardiac origin with ST-elevation on ECG.
- In patients who are comatose and with ROSC after OHCA of suspected cardiac origin without ST-elevation on ECG It is reasonable to consider an emergency cardiac catheterisation lab evaluation in patients with the highest risk of coronary cause cardiac arrest.

First aid

A section on first aid is included for the first time in the 2015 ERC Guidelines.

Principles of education in resuscitation

The following is a summary of the most important new views or changes in recommendations for education in resuscitation since the last ERC guidelines in 2010.

Training

- In centres that have the resources to purchase and maintain high fidelity manikins, we recommend their use. The use of lower fidelity manikins however is appropriate for all levels of training on ERC courses.
- Directive CPR feedback devices are useful for improving compression rate, depth, release, and hand position. Tonal devices improve compression rates only and may have a detrimental effect on compression depth while rescuers focus on the rate.
- The intervals for retraining will differ according to the characteristics of the participants (e.g. lay or healthcare). It is known that CPR skills deteriorate within months of training and therefore annual retraining strategies may not be frequent enough. Whilst optimal intervals are not known, frequent 'low dose' retraining may be beneficial.
- Training in non-technical skills (e.g. communication skills, team leadership and team member roles) is an essential adjunct to the training of technical skills. This type of training should be incorporated into life support courses.

- Emergency medical dispatchers have an influential role to play in guiding lay rescuers how to deliver CPR. This role needs specific training in order to deliver clear and effective instructions in a stressful situation.

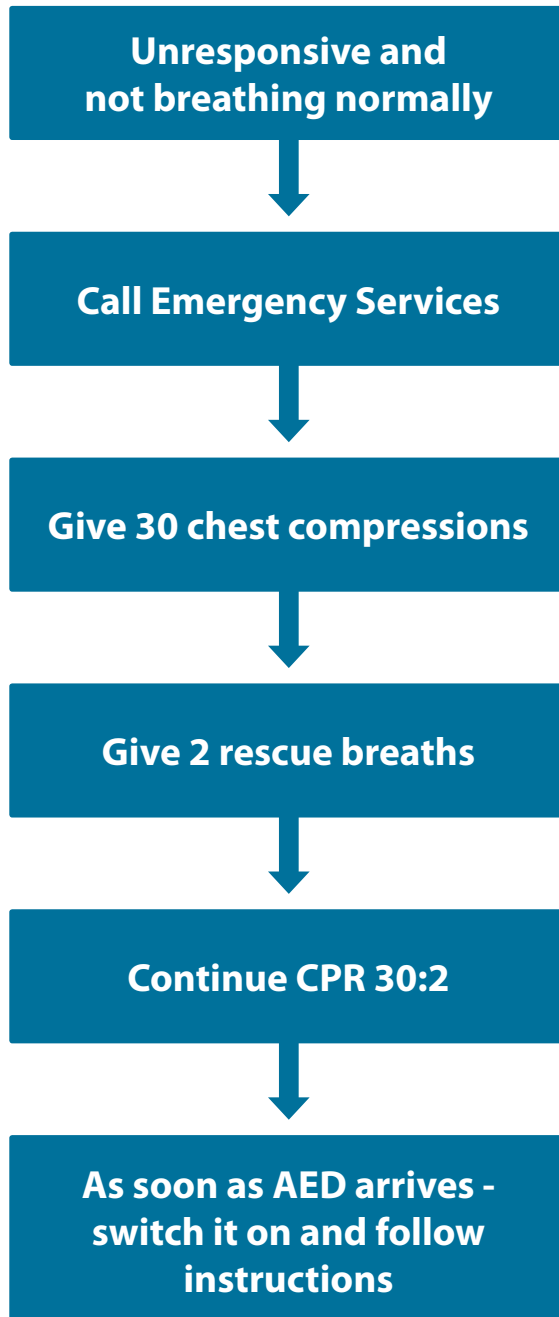
Implementation

- Data-driven performance-focused debriefing has been shown to improve performance of resuscitation teams. We highly recommend its use for teams managing patients in cardiac arrest.
- Regional systems including cardiac arrest centres are to be encouraged, as there is an association with increased survival and improved neurological outcome in victims of out-of-hospital cardiac arrest.
- Novel systems are being developed to alert bystanders to the location of the nearest AED. Any technology that improves the delivery of swift bystander CPR with rapid access to an AED is to be encouraged.
- “It takes a system to save a life” [<http://www.resuscitationacademy.com/>]. Healthcare systems with a responsibility for the management of patients in cardiac arrest (e.g. EMS organisations, cardiac arrest centres) should evaluate their processes to ensure that they are able to deliver care that ensures the best achievable survival rates.

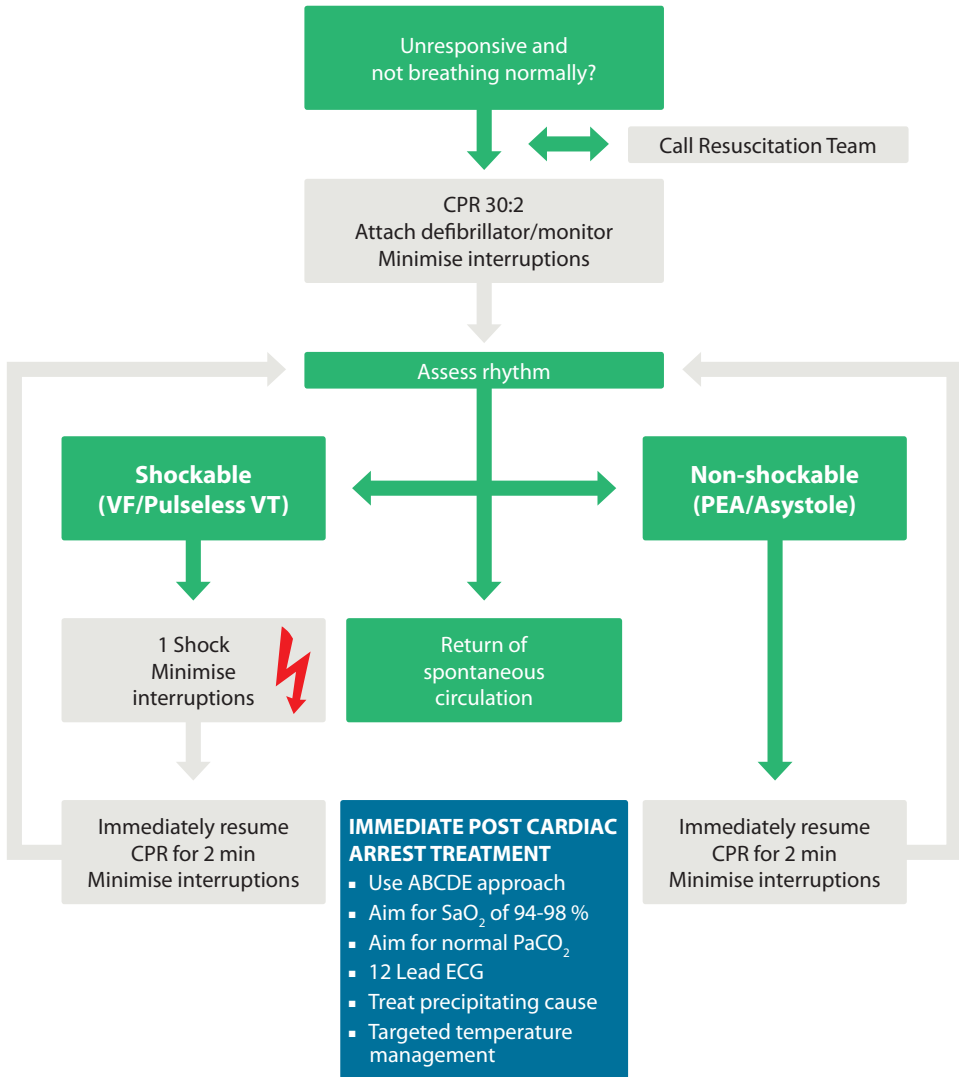
The ethics of resuscitation and end-of-life decisions

The 2015 ERC Guidelines include a detailed discussion of the ethical principles underpinning cardiopulmonary resuscitation.

Basic Life Support



Advanced Life Support



DURING CPR

- Ensure high quality chest compressions
- Minimise interruptions to compressions
- Give oxygen
- Use waveform capnography
- Continuous compressions when advanced airway in place
- Vascular access (intravenous or intraosseous)
- Give adrenaline every 3-5 min
- Give amiodarone after 3 shocks

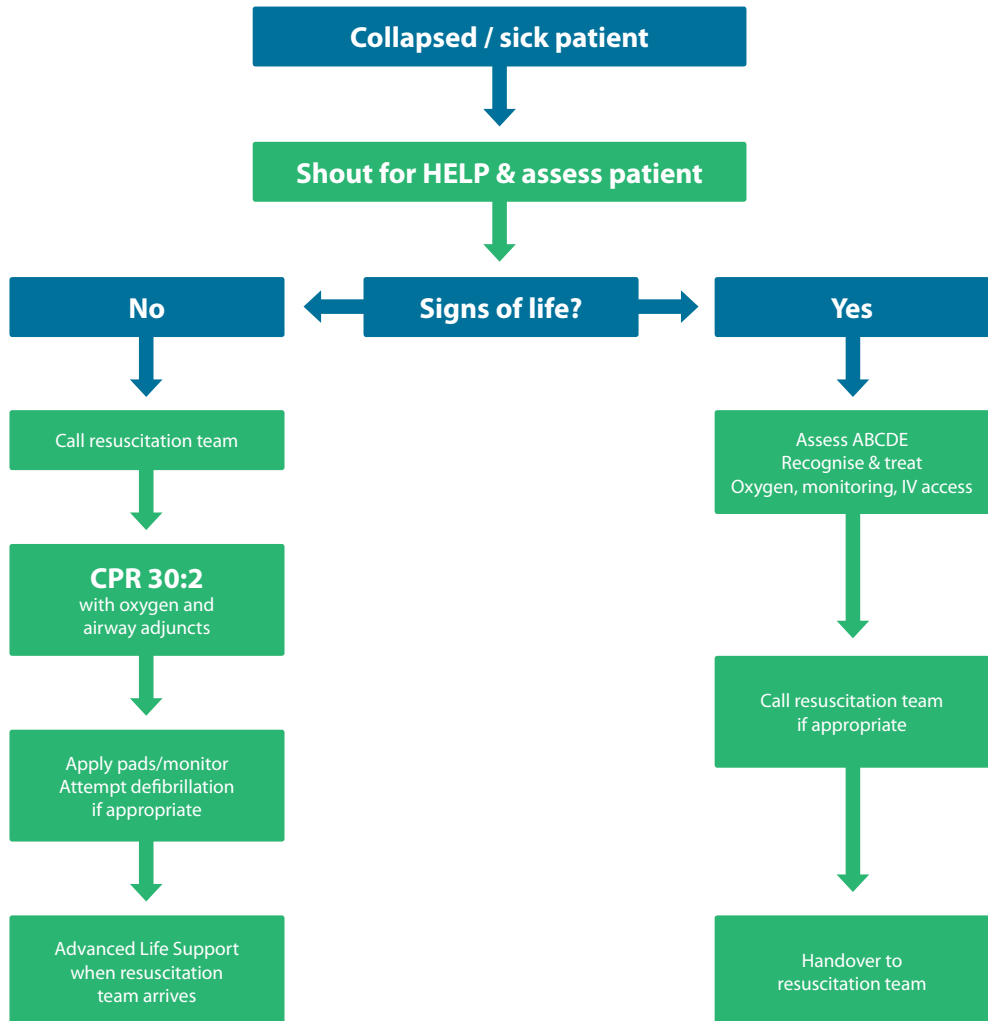
TREAT REVERSIBLE CAUSES

- | | |
|-------------------------------|------------------------------------|
| Hypoxia | Thrombosis – coronary or pulmonary |
| Hypovolaemia | Tension pneumothorax |
| Hypo-/hyperkalaemia/metabolic | Tamponade – cardiac |
| Hypothermia/hyperthermia | Toxins |

CONSIDER

- Ultrasound imaging
- Mechanical chest compressions to facilitate transfer/treatment
- Coronary angiography and percutaneous coronary intervention
- Extracorporeal CPR

In-hospital Resuscitation



Anaphylaxis

Anaphylactic reaction?



Assess using ABCDE approach



Diagnosis - look for:

- Acute onset of illness
- Life-threatening Airway and/or Breathing and/or Circulation problems¹
- And usually skin changes



- **Call for help**
- Lie patient flat with raised legs (if breathing allows)



Adrenaline²



When skills and equipment available:

- Establish airway
- High flow oxygen
- IV fluid challenge³
- Chlorphenamine⁴
- Hydrocortisone⁵

Monitor:

- Pulse oximetry
- ECG
- Blood pressure

¹Life-threatening problems:

Airway: swelling, hoarseness, stridor
Breathing: rapid breathing, wheeze, fatigue, cyanosis, SpO₂ < 92%, confusion
Circulation: pale, clammy, low blood pressure, faintness, drowsy/coma

² Adrenaline (give IM unless experienced with IV adrenaline)
 IM doses of 1:1000 adrenaline (repeat after 5 min if no better)

- Adult 500 mcg IM (0.5 mL)
- Child more than 12 years 500 mcg IM (0.5 mL)
- Child 6-12 years 300 mcg IM (0.3 mL)
- Child less than 6 years 150 mcg IM (0.15 mL)

Adrenaline IV to be given **only by experienced specialists**
 Titrate: Adults 50 mcg; Children 1 mcg kg⁻¹

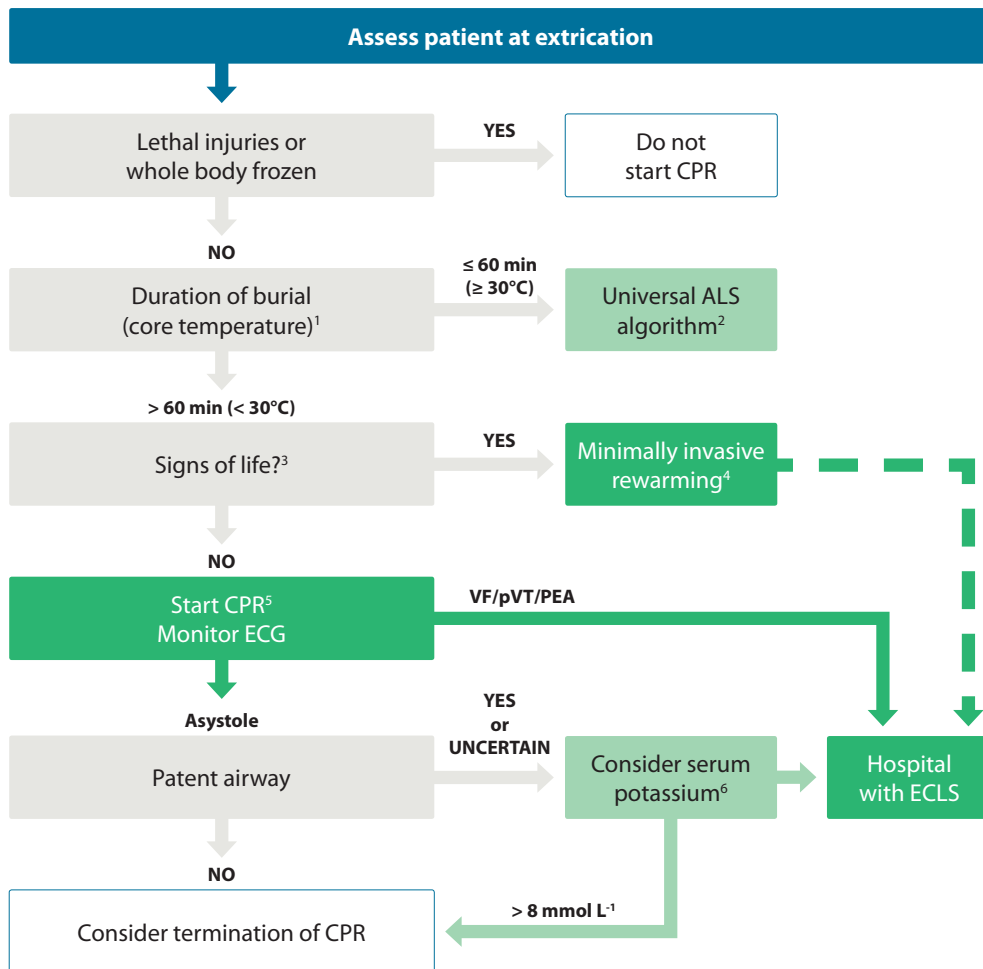
³ IV fluid challenge (crystalloid):

Adult	500 - 1000 mL
Child	20 mL kg ⁻¹

Stop IV colloid if this might be the cause of anaphylaxis

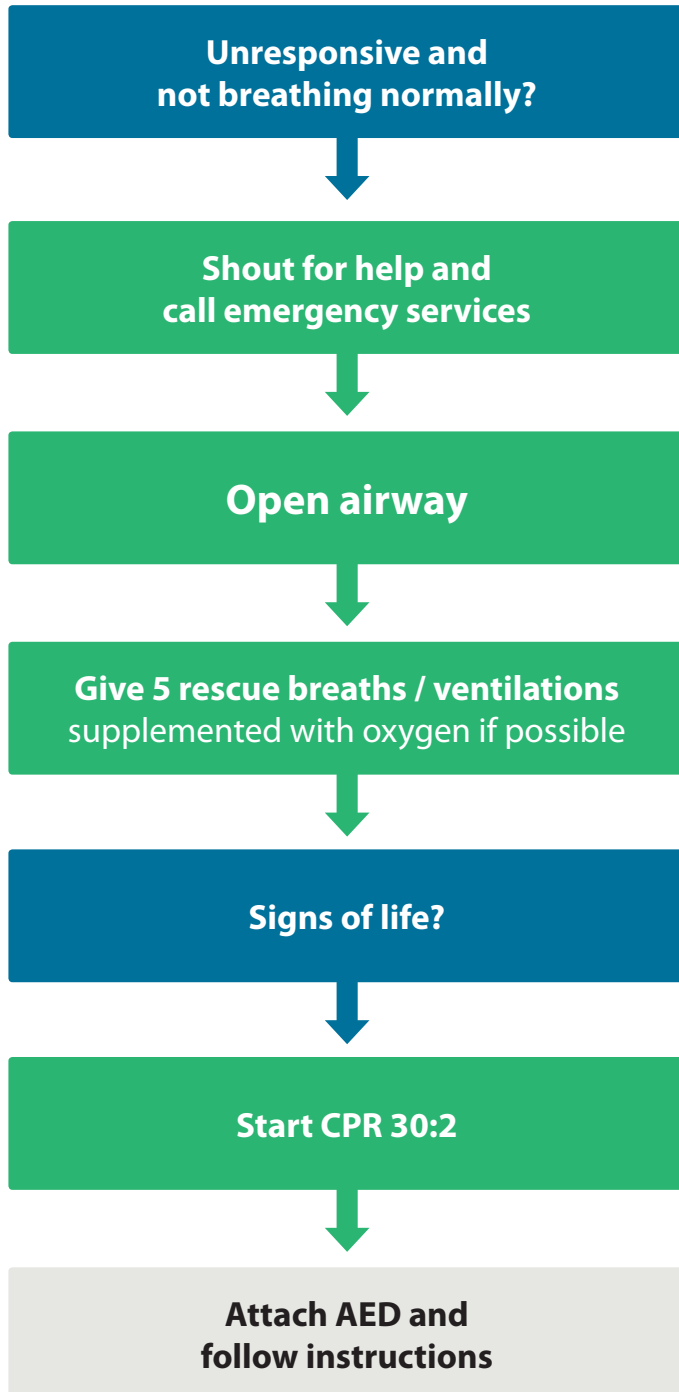
	⁴Chlorphenamine (IM or slow IV)	⁵Hydrocortisone (IM or slow IV)
Adult or child more than 12 years	10 mg	200 mg
Child 6 - 12 years	5 mg	100 mg
Child 6 months to 6 years	2.5 mg	50 mg
Child less than 6 months	250 mcg kg ⁻¹	25 mg

Avalanche Accident

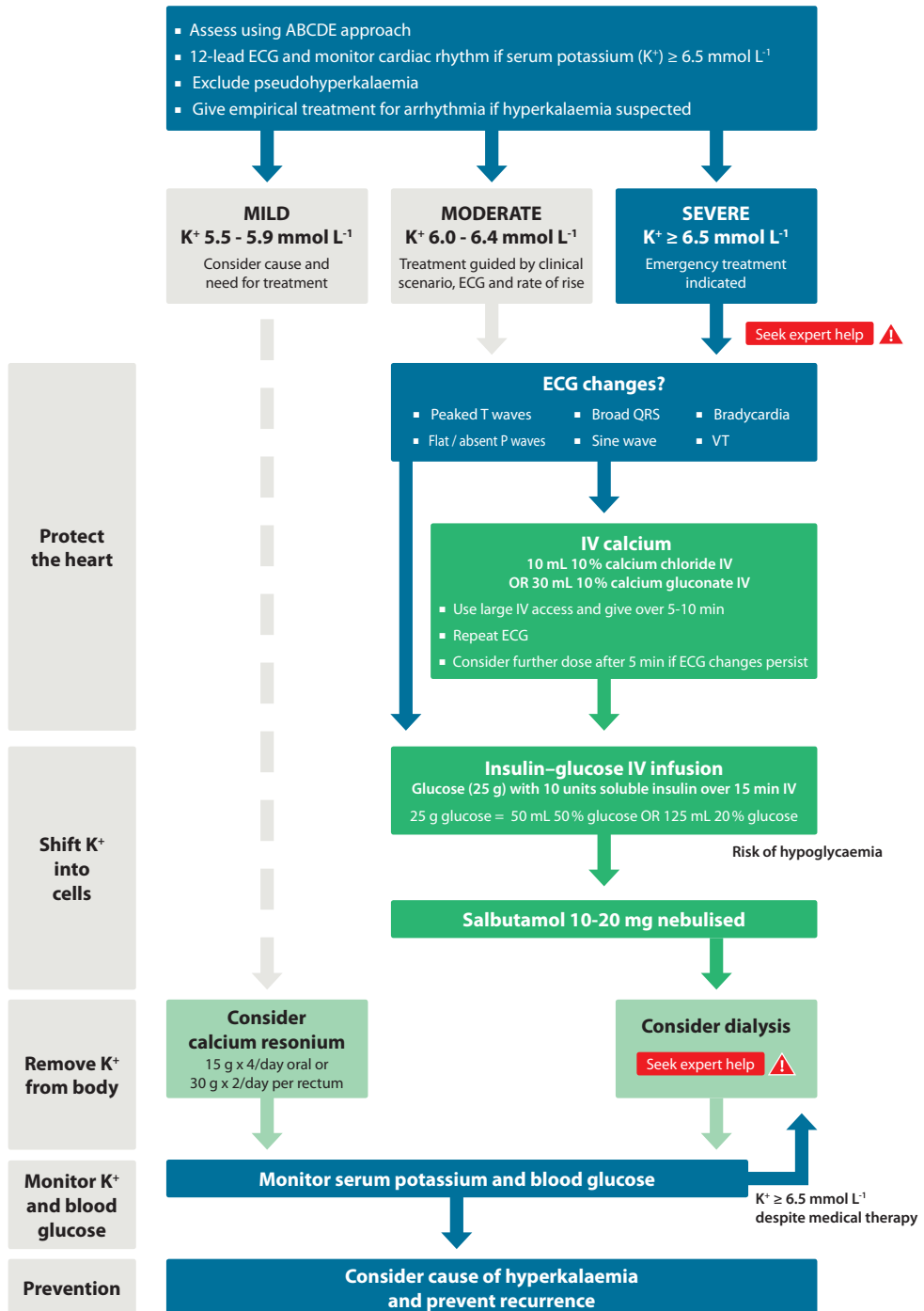


- ¹. Core temperature may substitute if duration of burial is unknown
- ². Transport patients with injuries or potential complications (e.g. pulmonary oedema) to the most appropriate hospital
- ³. Check for spontaneous breathing and pulse for up to 1 min
- ⁴. Transport patients with cardiovascular instability or core temperature < 28°C to a hospital with ECLS (extracorporeal life support)
- ⁵. Withhold CPR if risk to the rescue team is unacceptably high
- ⁶. Crush injuries and depolarising neuromuscular blocking drugs may elevate serum potassium

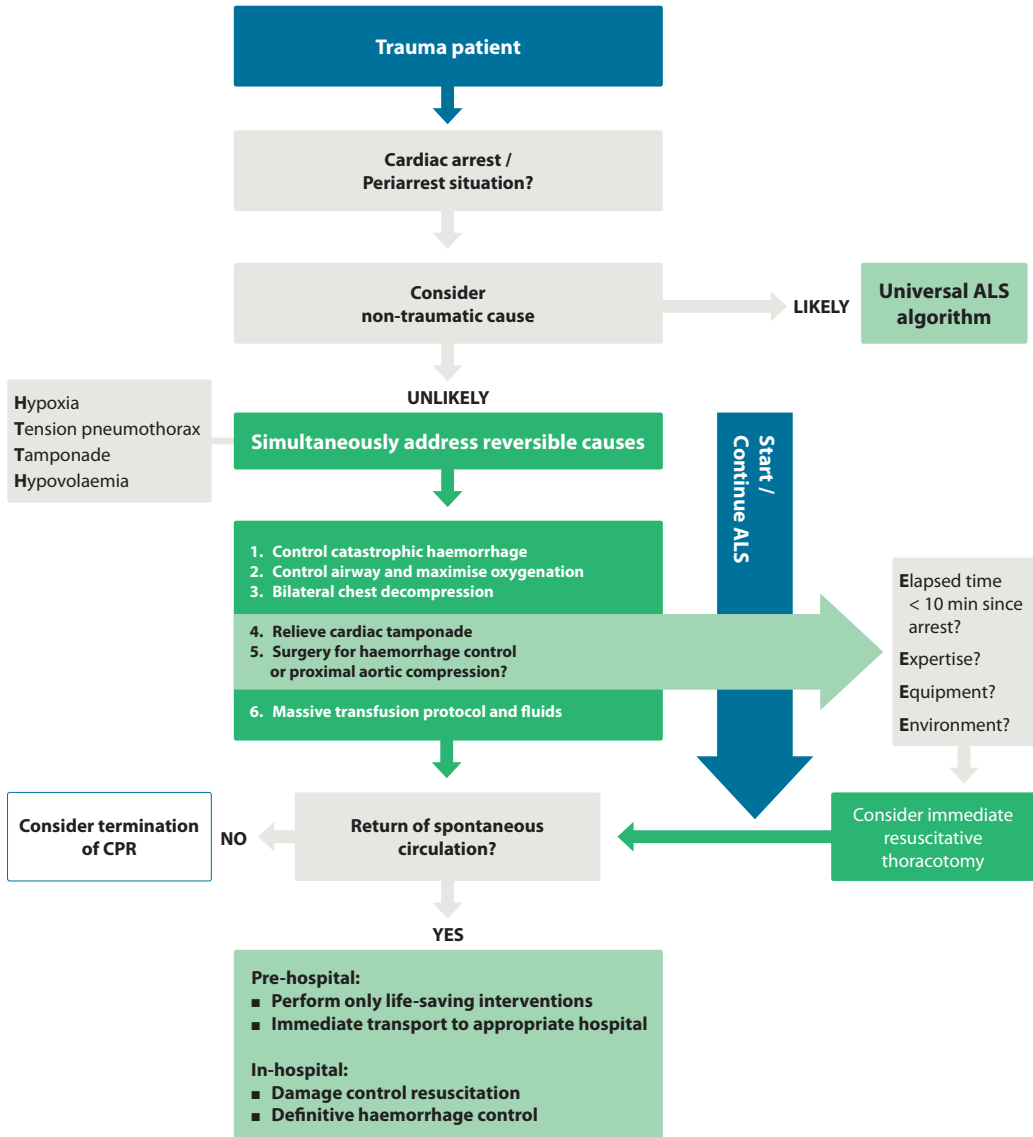
Drowning



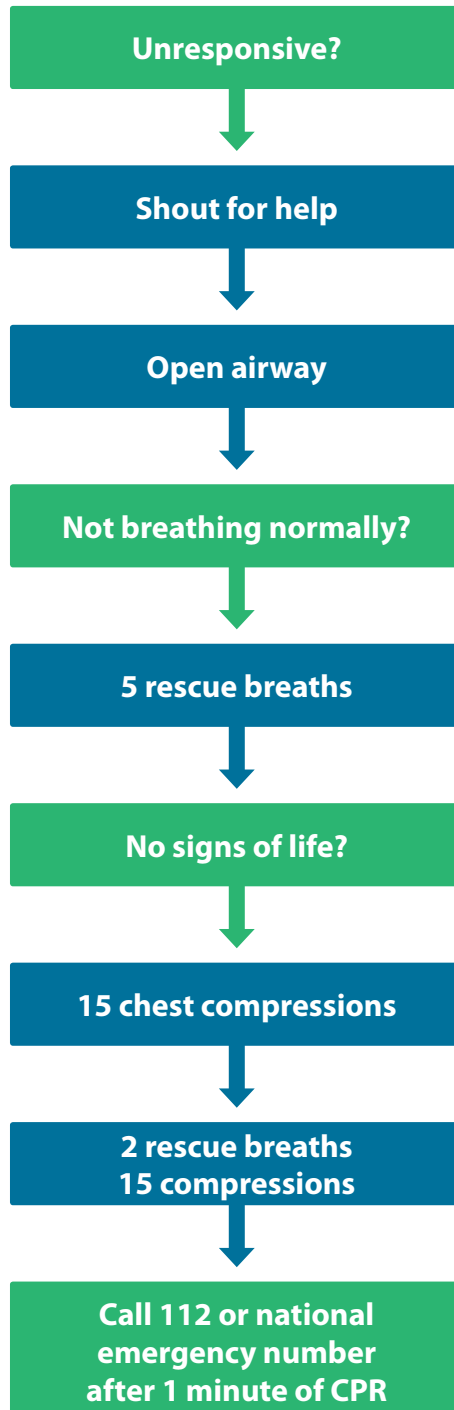
Hyperkalaemia



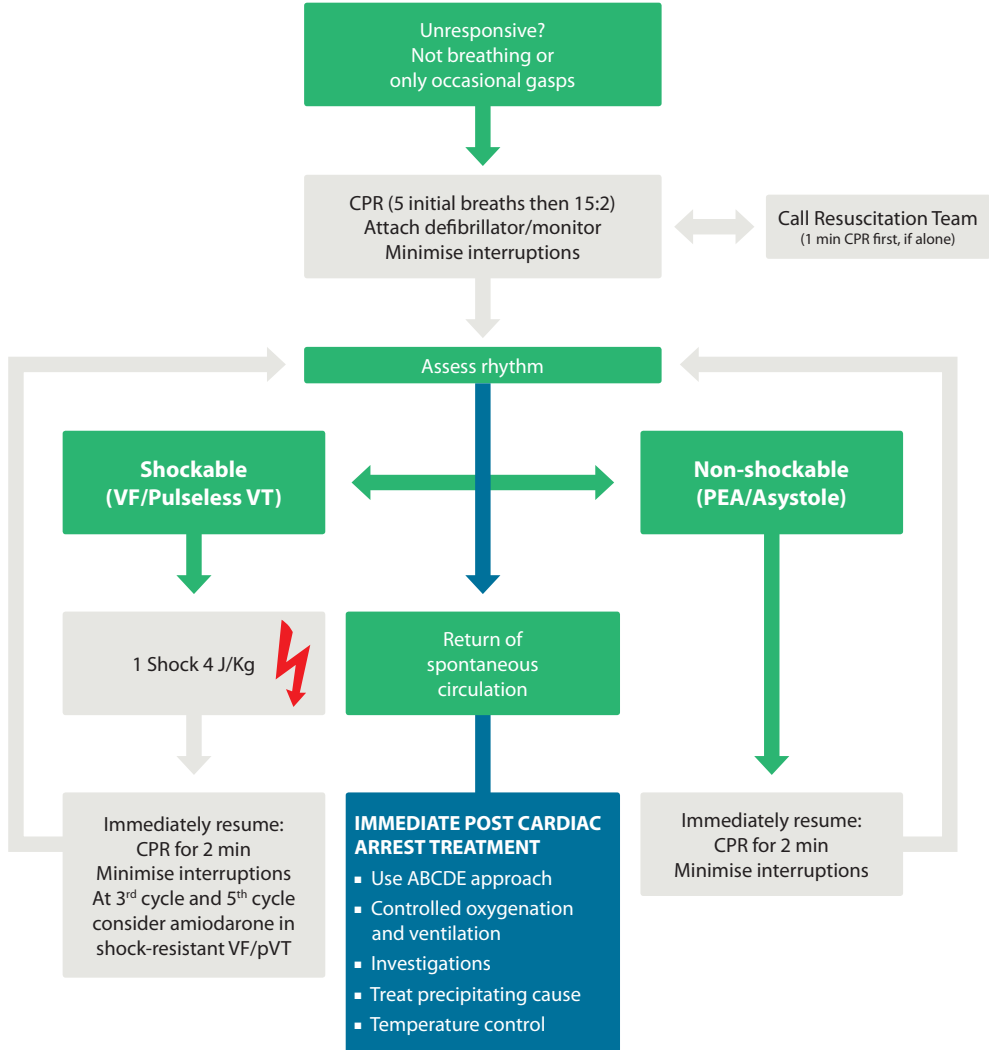
Traumatic Cardiac Arrest



Paediatric Basic Life Support



Paediatric Advanced Life Support



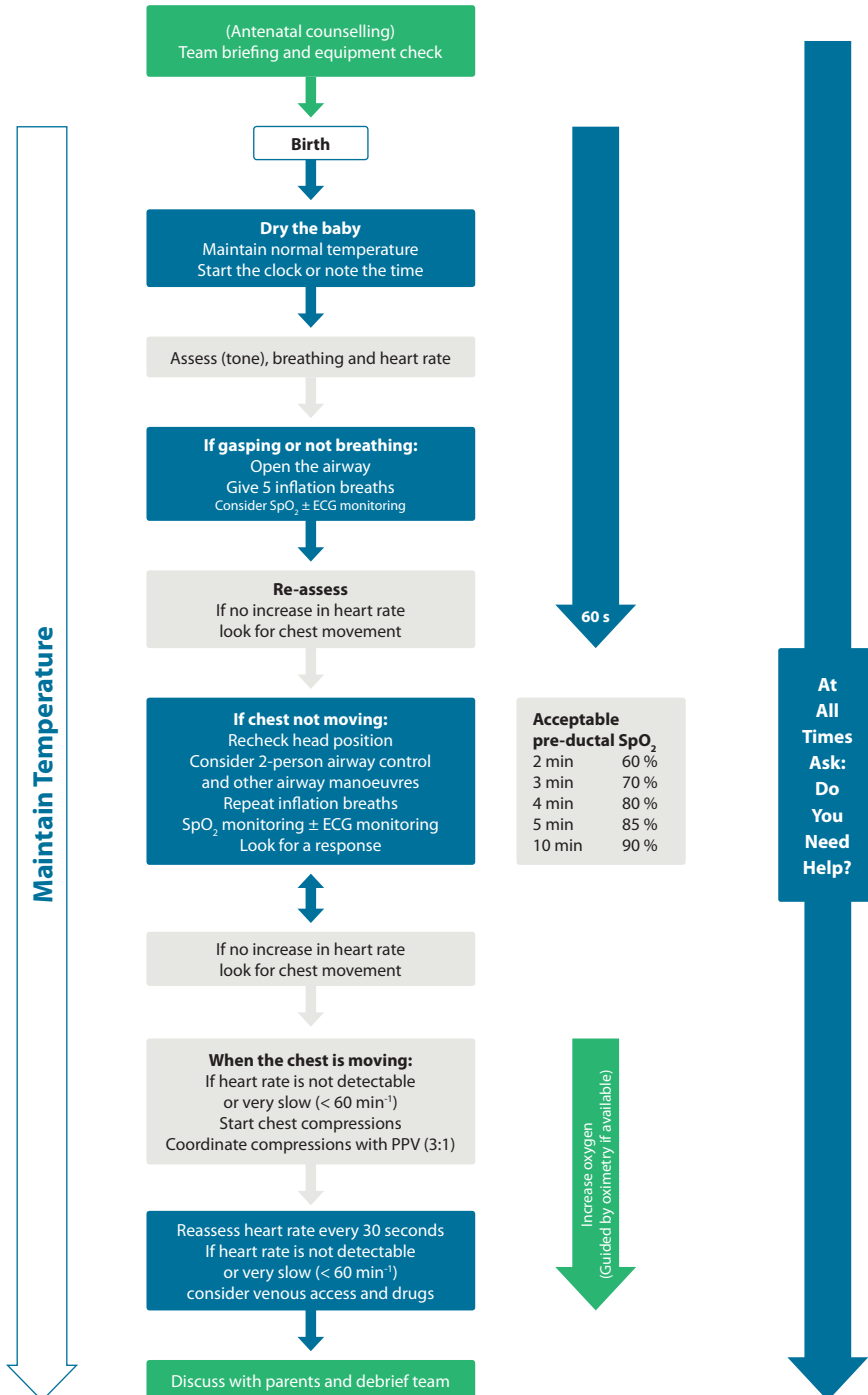
DURING CPR

- Ensure high-quality CPR: rate, depth, recoil
- Plan actions before interrupting CPR
- Give oxygen
- Vascular access (intravenous, intraosseous)
- Give adrenaline every 3-5 min
- Consider advanced airway and capnography
- Continuous chest compressions when advanced airway in place
- Correct reversible causes

REVERSIBLE CAUSES

- Hypoxia
- Hypovolaemia
- Hyper/hypokalaemia, metabolic
- Hypothermia
- Thrombosis (coronary or pulmonary)
- Tension pneumothorax
- Tamponade (cardiac)
- Toxic/therapeutic disturbances

Newborn Life Support



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