Prehospital Cardiac Arrest

CHAPTER 14

Learning outcomes

To understand:

- **The role of telephone-advised cardiopulmonary resuscitation (CPR)**
- **The current position on CPR versus defibrillation first**
- **How to change over efficiently from an AED to a manual defibrillator**
- **Principles of prehospital airway management**
- **The importance of effective handover to hospital staff**
- **Rules for stopping resuscitation**
- **The potential role of cardiac arrest centres**

Introduction

A prehospital section has been included for the first time in the Resuscitation Council (UK) Advanced Life Support (ALS) course manual. The aim is to bring together resuscitation topics of specific relevance to the pre-hospital emergency medical services (EMS). The increased emphasis on the importance of minimally interrupted high-quality chest compressions and reducing the pre-shock pause by continuing chest compressions while the defibrillator is charged demands a well structured, monitored training programme for prehospital EMS practitioners. This should include comprehensive competency-based training and regular opportunities to refresh skills. It is recognised that in most cases prehospital resuscitation has to be managed by fewer practitioners than would normally be present at an in-hospital arrest; also transportation to a receiving centre adds an extra dimension. This emphasises the need for a structured and disciplined approach. The Resuscitation Council (UK) ALS course provides the ideal platform to develop and practise resuscitation skills and strengthen the multidisciplinary team approach.

Telephone-advised CPR

Telephone-advised CPR has been included in the 2010 Resuscitation Council (UK) Guidelines because:

- there is widespread use of telephone triage systems that include advice for a rescuer attending a cardiac arrest victim before professional help arrives;
- the wide availability of mobile phones makes it likely that there will be a phone available at the site where the victim has collapsed;
- there is robust research examining best practice of both the diagnosis of cardiac arrest by telephone and also the content and delivery of subsequent instructions provided to rescuers;
- in adults, telephone-advised compression-only CPR produces better survival rates than telephone-advised conventional CPR (chest compressions and mouth-to-mouth ventilation);
- it has been acknowledged that the time to first compression can be reduced significantly if a lay bystander can deliver chest compressions while waiting for professionals to arrive.

The aims of providing guidance on telephone advice are:

- to enable an early correct diagnosis of cardiac arrest to be made;
- to enable the lay rescuer to start early, effective CPR, minimising the time from collapse to the first effective chest compression, and to continue correctly performed CPR until help arrives.

Telephone triage guidelines

The use of telephone triage to grade the urgency of emergency calls to the EMS is used throughout the UK and is becoming an integral part of the Chain of Survival for victims of cardiac arrest. As part of the call, if appropriate, call handlers will offer CPR instructions to the caller. After out-of-hospital cardiac arrest, help from the EMS will be accessed by telephone and because of the widespread use of mobile phones it is common for a phone to be available at the point where resuscitation is taking place. The opportunity to provide instructions by phone on how to give CPR enables the time to the first chest compression to be reduced dramatically, compared with waiting for the arrival of the EMS. The shorter the time until chest compressions are commenced, the higher the survival rate. However, significant delays in giving advice over the phone and/or poor quality CPR will limit the benefits.

Standardised advice to bystanders should increase the chance that the cardiac arrest will be diagnosed and treated correctly. Further research on this topic will help to improve outcome.

Telephone triage systems

In the UK, call handlers who answer 999 calls may have no background medical training apart from that provided when they were trained to use the system. They read the triage questions from a screen and the deviation allowed from the precise wording in either the question or the advice supplied, varies from supplier to supplier according to licence.

Diagnosis

The diagnosis of cardiac arrest may be difficult over the telephone. Palpation of the carotid pulse by laypeople is unreliable for the diagnosis of cardiac arrest. Absence of breathing can be a better indicator of cardiac arrest, but many cardiac arrest victims gasp initially (agonal breathing) and this is often misinterpreted by the lay rescuer as breathing. Consequently, the call handler should ask if the victim is “breathing normally” instead of simply “breathing”. A few cardiac arrest victims will have seizures. Seizure activity as a feature of cardiac arrest can cause confusion and delay the correct diagnosis. Asking whether the patient is a known epileptic may help to reduce the risk of patients with epilepsy receiving bystander CPR inappropriately.

Telephone-advised compression-only CPR

When EMS response times are short (< 5 min), there is some evidence that compression-only CPR produces at least equivalent outcomes to conventional CPR (chest compressions and mouth-to-mouth ventilation). In adults, telephone-advised compression-only CPR produces better survival rates than telephone-advised conventional CPR. Rescuers may be more willing to give resuscitation if they do not have to provide ventilation. In children, 70% of out-of-hospital cardiac arrests are asphyxial in origin and survival rates are better if they are provided with both chest compressions and ventilations. However, even in children, after cardiac arrest from a primary cardiac cause, there is no difference in survival after compression-only or conventional CPR - either technique produces better survival rates than no CPR. Telephone-advised CPR guidelines provide instruction in compression-only CPR for both adults and children because it is quicker and easier to describe.

Defibrillation

CPR versus defibrillation first

Defibrillation is a key link in the Chain of Survival and is one of the few interventions that has been shown to improve outcome from ventricular fibrillation/pulseless ventricular tachycardia (VF/VT) cardiac arrest. The probability of successful defibrillation and subsequent survival to hospital discharge declines rapidly with time and the ability to deliver early defibrillation is one of the most important factors in determining survival from cardiac arrest.

Several studies have examined whether a period of CPR before defibrillation is beneficial, particularly in patients with an unwitnessed arrest or prolonged collapse without resuscitation. A review of evidence for the 2005 guidelines resulted in the recommendation that it was reasonable for EMS personnel to give a period of about 2 min of CPR (i.e. about five cycles at 30:2) before defibrillation in patients with prolonged collapse (> 5 min). This recommendation was based on clinical studies in which response times exceeded 4 - 5 min and in which a period of 1.5 - 3 min of CPR by paramedics or EMS physicians before shock delivery, compared with immediate defibrillation, improved return of spontaneous circulation (ROSC), survival to hospital discharge and one-year survival for adults with out-of-hospital VF/VT.

In contrast, in two randomised controlled trials, a period of 1.5 - 3 min of CPR by EMS personnel before defibrillation did not improve ROSC or survival to hospital discharge in patients with out-of-hospital VF/VT, regardless of EMS response interval. Four other studies have also failed to demonstrate significant improvements in overall ROSC or survival to hospital discharge with an initial period of CPR.

The duration of collapse is frequently difficult to estimate accurately and there is evidence that performing chest compressions while preparing and charging a defibrillator improves the probability of survival. For these reasons, in any cardiac arrest that they have not witnessed, EMS personnel should provide high-quality CPR while a defibrillator is prepared, applied and charged, but routine delivery of a specified period of CPR (e.g. 2 - 3 min) before rhythm analysis and shock delivery is no longer recommended.

Transition from AED to manual defibrillator

In many situations, an automated external defibrillator (AED) is used to provide initial defibrillation but is subsequently swapped for a manual defibrillator on arrival of EMS personnel. If such a swap is done without considering the phase of the AED cycle, the next shock may be delayed, which may compromise outcome. For this reason, EMS personnel should leave the AED connected while securing the airway and IV access. The AED can be left attached for the next rhythm analysis and, if indicated, shock delivery, before being swapped for the manual defibrillator.

One shock versus three-shock sequence

A three-stacked shock strategy (as opposed to a single shock) may be considered when a conscious patient has a witnessed arrest when already connected to a manual defibrillator with self-adhesive defibrillation pads.

Although there are no data supporting a three-shock strategy in any circumstances, it is unlikely that chest compressions will improve the already very high chance of ROSC when defibrillation occurs early in the electrical phase, immediately after onset of VF.

Prehospital airway management

There is insufficient evidence to support or refute the use of any specific technique to maintain an airway and provide ventilation in adults with prehospital or in-hospital cardiac arrest. Tracheal intubation has been perceived as the optimal method of providing and maintaining a clear and secure airway during cardiac arrest but data are accumulating on the challenges associated with prehospital intubation. It is now strongly recommended that tracheal intubation should be used only when trained personnel are available to carry out the procedure with a high level of skill and confidence. In the absence of experienced personnel the use of supraglottic airway devices (SADs) during CPR is probably more rational. However, there are only poor-quality data on the pre-hospital use of these devices during cardiac arrest. The use of SADs is discussed in more detail in Chapter 7.

Tracheal intubation

The perceived advantages of tracheal intubation over bag-mask ventilation include: enabling ventilation without interrupting chest compressions, enabling effective ventilation (particularly when lung and/or chest compliance is poor), minimising gastric inflation and therefore the risk of regurgitation, protection against pulmonary aspiration of gastric contents, and the potential to free a rescuer's hands for other tasks.

Use of the bag-mask is more likely to cause gastric distension, which, theoretically, is more likely to cause regurgitation and aspiration. However, there are no reliable data to indicate that the incidence of aspiration is any higher in cardiac arrest patients ventilated using a bag-mask compared with those ventilated via a tracheal tube.

The disadvantages of tracheal intubation over bag-valve-mask ventilation include:

- The risk of an unrecognised misplaced tracheal tube in patients with out-of-hospital cardiac arrest, the documented incidence ranges from 0.5 - 17%.
- A prolonged period without chest compressions while intubation is attempted: in a study of prehospital intubation by paramedics during 100 cardiac arrests, the total duration of the interruptions in CPR associated with tracheal intubation attempts was 110 s and in 25% the interruptions were for > 3 min.
- A comparatively high failure rate: intubation success rates correlate with the experience of the intubator.

Healthcare personnel who undertake prehospital intubation should do so only within a structured, monitored programme, which should include comprehensive competency-based training and regular opportunities to refresh skills. Rescuers must weigh the risks and benefits of intubation against the need to provide effective chest compressions. The intubation attempt may require some interruption of chest compressions but, once an advanced airway is in place, ventilation will not require interruption of chest compressions and the patient may be attached to a mechanical ventilator device initially set to deliver a tidal volume of 6 - 7 ml kg^{-1} at 10 breaths min^{-1}. Personnel skilled in advanced airway management should be able to undertake laryngoscopy without stopping chest compressions; a brief pause in chest compressions will be required only as the tube is passed between the vocal cords. Alternatively, to avoid any interruptions in chest compressions, the intubation attempt may be deferred until ROSC. No intubation attempt should interrupt chest compressions for > 10 s. After intubation, confirm correct tube placement and secure the tube adequately.

With the increasing availability of efficient intraosseous (IO) devices, and the lack of efficacy of tracheal drug administration, tracheal administration of drugs is no longer recommended.

Confirmation of the correct placement of the tracheal tube

Unrecognised oesophageal intubation is the most serious complication of attempted tracheal intubation. Routine use of primary and secondary techniques to confirm correct placement of the tracheal tube should reduce this risk. Primary assessment should include observation of bilateral chest expansion, bilateral auscultation in the axillae (breath sounds should be equal and adequate), and auscultation over the epigastrium (breath sounds should not be heard). Clinical signs of correct tube placement (condensation in the tube, chest rise, breath sounds on auscultation of lungs, and inability to hear gas entering the stomach) are not completely reliable. Secondary confirmation of tracheal tube placement by an $ETCO_2$ or oesophageal detector device should reduce the risk of unrecognised oesophageal intubation. If there is doubt about correct tube placement, use the laryngoscope and look directly to see if the tube passes through the vocal cords. None of the secondary confirmation techniques will differentiate between a tube placed in a main bronchus and one placed correctly in the trachea.

Waveform capnography is the most sensitive and specific way to confirm and monitor continuously the position of a tracheal tube in victims of cardiac arrest. Existing portable monitors may make capnographic initial confirmation and continuous monitoring of tracheal tube position feasible in almost all settings where intubation is performed, including out of hospital. In the absence of a waveform capnograph it may be preferable to use a supraglottic airway device when advanced airway management is indicated.

CPR during transportation to hospital

During transportation to hospital, manual CPR is often performed poorly; mechanical CPR can maintain high quality CPR during transfer by land ambulance or helicopter. Mechanical devices also have the advantage of allowing defibrillation without interrupting chest compressions. However, these devices have to be applied efficiently if prolonged interruption to chest compressions is to be avoided. Ongoing multicentre prospective trials should eventually provide the data to determine the precise role of mechanical devices in prehospital resuscitation.

Hospital handover

If a cardiac arrest victim is transported to hospital, clear and accurate communication and documentation are essential elements of the handover to hospital staff. Vital information may be lost or misinterpreted if communication between EMS practitioners and hospital staff is not effective.

If resuscitation is continuing en route to hospital, a pre-alert message is essential to ensure that emergency department staff and/or the hospital resuscitation team are ready to receive the patient. This gives time for the hospital resuscitation team to elect a team leader and assign roles to team members. Specific interventions to treat potentially reversible causes or specialist intervention can be arranged.

Emergency medical services personnel need to be completely focused on communicating vital information about the patient, the circumstances surrounding the resuscitation and actions taken. This has to be done against a background of considerable activity and with the added pressure of time. Hospital staff will be focused on beginning their own assessment and treatment of the patient, but this must not prevent them from listening to the vital information provided by the EMS personnel. A structured approach will enhance the handover and make the transition as rapid and effective as possible. Communication failure has been cited as a contributory factor in cases of error and harm to patients. A British Medical Association document *Safe Handover; Safe Patients* gives guidance to ensure that the risks involved in the process of transferring clinical responsibility are minimised (http://www.bma.org.uk/employmentandcontracts/working_arrangements/Handover.jsp).

The ALS course enables prehospital and hospital staff to understand each other's role and develops the multidisciplinary team approach.

Rules for stopping resuscitation

Following out-of-hospital cardiac arrest, failure of ALS-trained EMS personnel to achieve ROSC at the scene is associated with an extremely low probability of survival. The rare exception, where the transfer to hospital of a patient with ongoing CPR results in long-term good quality survival, is usually associated with special circumstances, such as pre-existing hypothermia or drug overdose. For this reason, attempts have been made to formulate and validate rules for stopping resuscitation that allow EMS personnel to stop the resuscitation attempt and pronounce life extinct without transporting the victim to hospital. One such rule recommends stopping CPR when there is no ROSC, no shocks are administered, and the arrest is not witnessed by EMS personnel. However, this rule was validated with defibrillation-only emergency medical technicians in Canada and may not apply to an EMS system staffed by paramedics. In the UK, guidelines from the Joint Royal Colleges Ambulance Service Liaison Committee (2006), advise that ambulance clinicians may stop resuscitation if **all** of the following criteria are met:

- 15 min or more has passed since the onset of collapse;
- no bystander CPR was given before arrival of the ambulance;
- there is no suspicion of drowning, hypothermia, poisoning/overdose, or pregnancy;
- asystole is present for > 30 s on the ECG monitor screen;

Pre-hospital resuscitation attempts are generally discontinued also if the rhythm remains asystole despite 20 min ALS except in cases of drowning and hypothermia.

Regionalisation of post-resuscitation care

Several studies with historical control groups have shown improved survival after implementation of a comprehensive package of post-resuscitation care that includes therapeutic hypothermia and percutaneous coronary intervention. There is also evidence of improved survival after out-of-hospital cardiac arrest in large hospitals with cardiac catheter facilities compared with smaller hospitals with no cardiac catheter facilities. Several studies of out-of-hospital adult cardiac arrest failed to demonstrate any effect of transport interval from the scene to the receiving hospital on survival to hospital discharge if ROSC was achieved at the scene and transport intervals were short (3 - 11 min). This implies that it may be safe to bypass local hospitals and transport the post-cardiac arrest patient to a regional cardiac arrest centre. There is indirect evidence that regional cardiac resuscitation systems of care improve outcome after ST elevation myocardial infarction (STEMI).

The implication from all these data is that specialist cardiac arrest centres and systems of care may be effective but, as yet, there is no direct evidence to support this hypothesis.

Key learning points

- In adults, telephone-advised compression-only CPR produces better survival rates than telephone-advised conventional CPR.
- EMS personnel should provide high-quality CPR while preparing, applying and charging a defibrillator, but a routine, specified period of CPR before shock delivery is not recommended.
- Tracheal intubation should be attempted only by those with a high level of skill and experience with the technique.
- Waveform capnography is the most sensitive and specific method for confirming the position of a tracheal tube in victims of cardiac arrest.

Further reading

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