Cardiopulmonary resuscitation and post-resuscitation care

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Abstract

Survival following cardiac arrest depends on early recognition and effective treatment with high-quality chest compressions with minimal interruption, ventilation, treatment of reversible causes, and defibrillation if appropriate. Successfully resuscitated patients can develop a 'SIRS-like' post-cardiac arrest syndrome. Post-cardiac arrest care includes coronary reperfusion, control of oxygenation and ventilation, circulatory support, glucose control, treatment of seizures, and therapeutic hypothermia. Prognostication in comatose survivors is challenging. Approximately one-third of cardiac arrest survivors admitted to intensive care are discharged home.

Keywords Asystole; cardiac arrest; cardiopulmonary resuscitation; defibrillation; hypothermia; post-resuscitation care; pulseless electrical activity; ventricular fibrillation

Royal College of Anaesthetists CPD Matrix: 1B03, 1B04, 3C00.

Learning objectives

After reading this article, you should be able to:

- describe the recognition and treatment of cardiac arrest in adults according to current guidelines, understanding the importance of high-quality chest compressions and minimizing interruptions to chest compressions
- describe a safe defibrillation technique that includes a brief pause in chest compressions to confirm shockable rhythm, charging during chest compressions, and a brief pause in compressions for shock delivery
- list post-cardiac arrest care interventions including the use of therapeutic hypothermia
- understand the difficulties of prognostication in comatose survivors of cardiac arrest

Introduction

There are an estimated 50,000 cardiac arrests treated annually in the UK. Of these, about 60% occur out-of-hospital. Post-cardiac arrest patients who remain comatose after successful restoration of a spontaneous circulation (ROSC) account for 1 in 17 intensive care unit (ICU) admissions in the UK. Ventricular fibrillation (VF) or pulseless ventricular tachycardia (VT) is the presenting rhythm in most out-of-hospital cardiac arrests. Early defibrillation is the effective treatment for VF/VT and each minute of delay decreases the chances of success by roughly 10%. Survival to hospital discharge after out-of-hospital cardiac arrest is 8–10%. The incidence of in-hospital cardiac arrest is about 1–5 per thousand admissions. Survival is greatly increased if the first rhythm recorded in cardiac arrest is shockable. In 80% of in-hospital cardiac arrests, however, the first monitored rhythm is asystole or pulseless electrical activity (PEA). Approximately 15–20% of patients suffering in-hospital cardiac arrests survive to hospital discharge. One-third of cardiac arrests survivors admitted to ICU are discharged from hospital and survival rates are improving. Most survivors have a good neurological outcome.

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The Chain of Survival

All four links in the Chain of Survival (Figure 1) must be strong to improve survival from cardiac arrest.

Early recognition and call for help

Recognition of the importance of chest pain and alerting the ambulance service can prevent out-of-hospital cardiac arrest. In the hospital, early identification of patients at risk of cardiac arrest using an early warning scoring system, alerting the resuscitation team or medical emergency team (MET), and appropriate treatment may prevent cardiac arrest. Here, we cover the issues following cardiac arrest.

Cardiopulmonary resuscitation

Diagnosis of cardiac arrest

Gasping (agonal breathing) after a sudden cardiac arrest (usually VF/VT) is common and can cause a delay in starting CPR. Rescuers should look for signs of life, including a pulse. If signs of life are absent or the rescuer is unsure, CPR should be started. In anaesthetized or intensive care unit (ICU) patients, the presence of monitoring will also help to make the diagnosis but should not cause delays in starting CPR. Chest compressions in a low cardiac output state are unlikely to be harmful.

Chest compressions

Chest compressions generate blood flow by increasing intrathoracic pressure and compressing the heart directly. At best, compressions achieve 25% of normal brain and myocardium perfusion. A higher coronary perfusion pressure (CPP = aortic diastolic pressure − left ventricular end diastolic pressure) achieved during CPR is associated with improved ROSC. Each time chest compressions stop, the CPP decreases rapidly. On resuming chest compressions, it takes time to achieve the same CPP that existed just before compressions were interrupted. Recent evidence points to the need for deeper chest compressions at a higher rate. The current recommended depth for chest compressions in an adult is 5–6 cm at a rate of 100–120 per minute. The compression to ventilation ratio is 30:2.

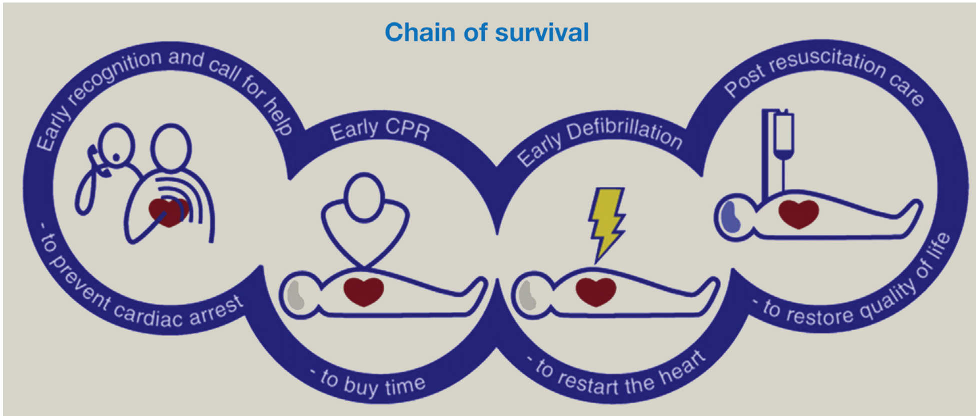

Figure 1

Advanced life support (ALS)

The ALS algorithm gives a standardized approach to cardiac arrest treatment (Figure 2).

Airway and ventilation

No specific airway and ventilation technique has been shown to improve cardiac arrest outcomes. Tracheal intubation by trained rescuers enables continuous chest compressions at 100–120 per minute without pauses for ventilations. Tracheal tube placement should be confirmed by auscultation of the chest during ventilation and waveform capnography. During effective CPR, there should be a carbon dioxide waveform. If no carbon dioxide is detected this should immediately raise the possibility of oesophageal intubation. Waveform capnography also provides a measure of CPR quality. High-quality CPR will increase end-tidal carbon dioxide, and ROSC is associated with a rapid increase in end-tidal carbon dioxide during CPR. The recommended ventilation rate is 10 per minute as a higher rate decreases the CPP. Compared with bag-mask ventilation, early ventilation with a supraglottic device reduces the incidence of gastric distension and regurgitation. If a supraglottic airway (e.g. laryngeal mask airway, I-gel) has been inserted, attempt continuous chest compressions without stopping for ventilations. If excessive gas leakage results in inadequate ventilation of the patient's lungs, interrupt chest compressions to enable ventilation.

Defibrillation

Defibrillation creates a current across the myocardium to depolarize a critical mass of the cardiac muscle enabling natural cardiac pacemaker tissue to resume control. Every 5-second increase in the pre-shock pause (the interval between stopping CPR and shock delivery) halves the chance of successful defibrillation. To minimize the pre-shock pause self-adhesive defibrillation pads should be applied without stopping CPR. Before stopping chest compressions, the team should plan what to do if defibrillation is appropriate including the importance of safety. Identify who will assess the ECG, and in the event of a shockable rhythm, identify who will charge the defibrillator and deliver the shock. Chest compressions should stop briefly to analyse the ECG and confirm a shockable rhythm. Chest compressions should then immediately resume whilst the defibrillator is charged. All other rescuers are instructed to 'stand clear' and ensure no oxygen is flowing across the chest (leave tracheal tubes or supraglottic devices attached to the breathing circuit or bag device). Once the defibrillator is charged, the rescuer performing chest compressions also stands clear. The shock is delivered with no one touching the patient. Chest compressions then immediately resume for a further 2 minutes. If there are delays due to difficulties in rhythm analysis or rescuers still in contact with the patient, chest compressions should be resumed whilst another plan is made.

Drugs

Drug use during CPR is supported by very little evidence. Adrenaline (1 mg every 4–5 minutes) increases the CPP during CPR and is associated with improved ROSC. Recent observational studies suggest that adrenaline use may be associated with worse survival and neurological function at 1 month. Amiodarone (300 mg) given to patients in VF refractory to defibrillation attempts has only been shown to improve short-term survival. Drug administration and attempts at intravenous access should not cause interruptions in chest compressions. The intra-osseous route should be used if intravenous access is not possible. The tracheal route is no longer recommended.

Reversible causes

Identify and treat reversible causes during CPR. These are divided into two groups of four based upon their initial letter – either H or T (Figure 2). Ultrasonography by trained rescuers whilst minimizing interruptions in CPR can help identify reversible causes (e.g. cardiac tamponade).

Post-cardiac arrest care

Resuscitation from cardiac arrest triggers a systemic inflammatory response syndrome (SIRS). This post-cardiac arrest syndrome consists of: (i) brain injury; (ii) myocardial dysfunction; (iii) systemic ischaemia/reperfusion response; and (iv) the precipitating disease that caused the cardiac arrest. A 'bundle' of early post-cardiac arrest care using 'Airway, Breathing, Circulation, Disability, Exposure' approach improves survival. The decision to admit a comatose post-cardiac arrest patient to ICU should be based predominantly on the patient's status before the cardiac arrest. To optimize their chances of survival, patients resuscitated from cardiac arrest benefit from admission to a designated cardiac arrest centre that offers both specialist ICU and cardiac catheter facilities.