Cardiopulmonary resuscitation

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Abstract

During core medical training, trainees should acquire sufficient knowledge and skills, and demonstrate appropriate attitudes and behaviours, to allow the competent assessment and resuscitation of patients who have suffered cardio-respiratory arrest within or outside hospital. The Resuscitation Council (UK) defines these attributes in its Resuscitation Guidelines of 2010. These revised guidelines took account of new evidence from clinical trials of cardiac arrest management. They emphasize the early provision of effective continuous chest compressions ('*push fast, firmly and immediately*') with minimal interruptions for defibrillation. Their advice to provide therapeutic cooling after initial recovery of circulation has recently been called into question.

Keywords Advanced life support; asystole; basic life support; cardiac arrest; cardiopulmonary resuscitation; defibrillation; pulseless electrical activity; ventricular fibrillation

What's new?

- The promotion of 'Hands-only' or 'Continuous Chest Compression-Cardiopulmonary Resuscitation' for lay responders to pre-hospital cardiac (rather than respiratory) arrest
- The concept of cardio-cerebral resuscitation
- The demonstration that prolonged therapeutic hypothermia to 33 °C in comatose survivors of cardiac arrest is no more effective than maintaining a temperature of 36 °C
- Increased provision of early investigation and percutaneous treatment of coronary artery disease in cardiac arrest survivors

Introduction

Outside hospital, abrupt cardio-respiratory arrest is often due to transient cardiac ischaemia resulting in ventricular fibrillation (VF), which soon degenerates to asystole. Other causes of cardiac standstill — primary asystole or pulseless electrical activity (PEA) — include potentially reversible conditions, such as profound hypoxia, hypovolaemia, pulmonary embolism, cardiac tamponade and tension pneumothorax. Long-term survival following pre-hospital cardio-respiratory arrest is unusual (<10% overall), but is 30–40% in those whose arrests are witnessed, who receive early cardiopulmonary resuscitation (CPR) from bystanders, and are then in VF when a defibrillator is applied.

Within hospital, rates of 6–7 cardiac arrest calls per 1000 admissions are reported.[1] The most common rhythm confronting the hospital cardiac arrest team is 'non-shockable' asystole/PEA. Outcomes are poor because arrest is frequently the conclusion of illnesses characterized by frailty and severe co-morbidities — factors that persist after successful resuscitation. For in-hospital cardiac arrest the rate of survival to discharge is about 20% overall, and has not changed over the past 15 years.[2]

'Primary' respiratory arrest — cessation of breathing with persisting effective cardiac activity — may occur as a consequence of acute respiratory diseases, such as asthma or pneumonia, chronic lung disease, airways obstruction, neuromuscular disease, or use of respiratory suppressant drugs such as morphine. Prognosis is more favourable because of the reversible nature of many of these causes.

Principles of treatment

The medical response to cardio-respiratory arrest has been likened to a 'chain of survival', with effective performance of each sequential component being necessary for the overall 'strength of the chain'. The principles of resuscitation comprise:

- appropriate use of 'Do-Not-Attempt-Resuscitation' (DNAR) orders
- rapid recognition that cardio-respiratory arrest has occurred
- a call for help to suitably trained personnel
- avoidance of danger to rescuers
- assessment of the circumstances of the collapse
- maintenance of sufficient coronary perfusion to allow subsequent reversal of non-perfusing cardiac rhythms
- maintenance of sufficient cerebral perfusion to avoid permanent neurological damage following restoration of spontaneous circulation (ROSC)
- maintenance of oxygenation during prolonged cardiac arrest or cases of respiratory arrest
- restoration of a perfusing cardiac rhythm with appropriate cardiac monitoring, defibrillation and drugs
- careful post-resuscitation care to mitigate post-arrest cerebral and cardiac dysfunction
- timely cessation of resuscitative attempts.

All clinicians should possess basic life support (BLS) skills and all those completing specialist training in general internal medicine should participate in UK Resuscitation Council-approved advanced life support courses, with re-certification every 3 years.

Guidelines and standards for CPR

The International Liaison Committee on Resuscitation (ILCOR) is one of the most effective and far-reaching non-governmental trans-national scientific collaborations. Through cyclical rigorous evaluations of systematic reviews every 5 years (most recently 2010), ILCOR produces recommendations for treatment which inform revisions of national guidelines.[3,4]

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In the UK, the Resuscitation Council (UK) has described Quality Standards to improve care and outcomes of patients who are deteriorating or who suffer cardio-respiratory arrest whether in or outside hospital.[5] One such standard is participation in the National Cardiac Arrest Audit of in-hospital CPR, which will allow risk-adjusted comparative outcome reporting; 75% of adult acute hospitals in England were participating in this audit as of March 2014.[6]

Whilst the basic principles governing CPR remain constant, the 2010 guidelines contained important changes based upon the following observations:

- soon after onset of VF when oxygenation is usually adequate, chest compressions appear more important than ventilation
- inadequate/interrupted chest compressions with excessive ventilation reduce coronary and cerebral perfusion during CPR
- initial biphasic defibrillation terminates VF in approximately 90% of cases but, even when organized cardiac rhythms ensue, immediate ROSC is rare
- following ROSC, survival may be improved by a package of interventions provided soon after successful resuscitation.

Basic life support

Recommended adult BLS[4] is shown in Figure 1. Infrequent gasping breaths commonly occur early after collapse with cardiac arrest. If in doubt, rescuers should act as if breathing is *not* normal and start chest compressions. Health professionals should also check for a carotid pulse during a 'breathing check' of less than 10 seconds. Two initial 'rescue breaths' are recommended only when there is obvious asphyxia, otherwise these delay the delivery of chest compressions and may deter bystanders from attempting resuscitation.

The heel of the hand should be placed over the middle of the lower half of the sternum. The preferred compression rate is 100—120/min with compression depth 5—6 cm and release of all pressure between compressions. This is tiring and, where possible, the rescuer performing compressions should be changed every 2 minutes. A variety of mechanical adjuncts and devices have been developed to deliver more effective and more reliable chest compressions. None of them has been shown consistently to be superior to standard (manual) CPR.[7,8]

The ratio of compressions to breaths within one 'cycle of CPR' is 30:2 (*but see below*) unless the airway has been secured with, for example, an endotracheal tube. Tracheal intubation often causes prolonged interruption of chest compressions and should be attempted only by highly skilled individuals. Ventilation should include an 'inspiratory' phase lasting 1 second with enough volume (often only 500—600 mL) to make the chest rise. Wherever possible, supplemental oxygen should be used. Excessive rate and depth of ventilation increases intrathoracic pressure, decreases venous return, and reduces coronary and cerebral perfusion.

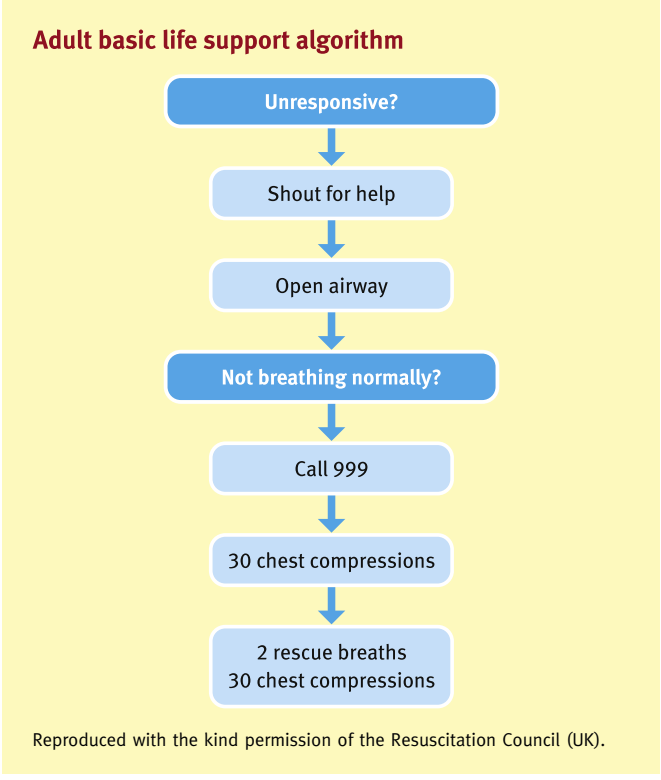

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Figure 1

Compression-only CPR

In some clinical trials, resuscitation using continuous chest compressions alone has been at least as, if not more, effective than standard CPR (incorporating cycles of compressions and ventilation).[9] Compression-only CPR is easier to teach and to describe (to lay people) over the telephone and lay responders are more likely to attempt it than standard CPR and so improve survival from pre-hospital cardiac arrest.[10] However, if members of the public (or indeed healthcare workers) are not taught mouth-to-mouth ventilation, victims of respiratory arrest, who rapidly become hypoxic, may be deprived of a technique — ventilation — that for them may be life-saving. Standard CPR remains the method of choice for trained rescuers.

Advanced life support

The present algorithm for advanced life support (ALS) is shown in Figure 2. If the collapse is witnessed and VF confirmed, a precordial thump is acceptable. Otherwise, CPR should start and, until the airway is secured, a compression-to-ventilation ratio of 30:2 should be used for each cycle of CPR. Thereafter, chest compressions (100—120/min) should continue uninterrupted and not synchronized with ventilations (10/min). All efforts should then focus on minimal interruptions to compressions.

Adhesive defibrillator electrodes are placed without stopping compressions — the 'right' electrode to the right of the sternum just below the clavicle; the 'left' electrode as far into the left axilla as possible, (not over breast tissue). Chest compressions are interrupted only to allow a brief assessment of cardiac rhythm (either as 'shockable' — VF or pulseless ventricular tachycardia — or 'non-shockable'). When a shock is indicated, compressions are resumed as the defibrillator charges and are stopped just before the first shock (150—200 J biphasic) is delivered, aiming for a 'pre-shock pause' of as little as 5 seconds. CPR should then restart immediately, without a rhythm check, and, unless signs of life