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. These attributes have been defined by the Resuscitation Council UK, which intends to publish new resuscitation guidelines in 2010. These revised guidelines will take account of new concepts regarding cardiac arrest and new evidence from clinical trials of cardiac arrest management. It is likely that emphasis will be placed on the early provision of effective continuous chest compressions and the relegation of 'rescue breathing' from initial management. Therapeutic cooling after initial recovery of circulation is also likely to be promoted as a way of maximizing the full functional recovery of survivors.

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 cardiac (rather than respiratory) arrest.
- The promotion of the concept of cardio-cerebral resuscitation.
- The use of mechanical chest compression devices.
- The use of early therapeutic hypothermia in survivors of cardiac arrest.

Introduction

Outside hospital, the underlying cause of abrupt cardio-respiratory arrest is often 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) — may be caused by potentially reversible causes, such as profound hypoxia, hypovolaemia, cardiac tamponade and tension pneumothorax. Long-term survival following pre-hospital cardio-respiratory arrest is unusual (<10% overall), but is 30–40% in the subgroup whose arrests are witnessed, who receive cardiopulmonary resuscitation (CPR) from bystanders, and who are in VF when a defibrillator is available at the scene.

Within hospital, the commonest rhythm confronting the cardiac arrest team is 'non-shockable' asystole/PEA. Whereas a rapid response should be available, the outcome is poor because the arrest is frequently the end result of severe co-morbidities. For cardiac arrests developing within hospital the rate of survival to discharge is about 20% overall, and has not changed over the past 15 years.[1]

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

Principles of treatment

The response to cardio-respiratory arrest is characterized by the 'chain of survival'. The principles of resuscitation comprise:

- appropriate use of 'Do Not Resuscitate' (DNR) orders
- rapid recognition that cardio-respiratory arrest has occurred
- a call for help to suitably trained personnel
- avoidance of danger to rescuers and victim
- 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
- correction of the immediate underlying problem with appropriate cardiac monitoring, defibrillation and drug use
- 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 for CPR

In 2005, following an exhaustive evaluation of the evidence underpinning management of cardio-respiratory arrest by the International Liaison Committee on Resuscitation,[2] Resuscitation Council UK published national guidelines.[3] These will be revised in 2010. Whilst the basic principles governing CPR remain constant, these revisions and the existing guidelines contain important changes based upon the following observations:

- early after onset of VF, oxygenation is usually adequate and chest compressions appear more important than ventilation
- inadequate/interrupted chest compressions with excessive ventilation reduce coronary and cerebral perfusion during

CPR; such interruptions are a frequent feature of resuscitation attempts
- when VF is prolonged, a period of BLS before defibrillation may increase survival
- initial biphasic defibrillation terminates VF in approximately 90% of cases but, even when organized cardiac rhythms ensue, immediate ROSC is rare.

Basic life support

Existing recommended adult BLS[3] is shown in Figure 1. Infrequent gasping breaths commonly (55%) 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 the 'breathing check'. Two initial 'rescue breaths' are recommended only when there is obvious asphyxia, otherwise they delay the delivery of chest compressions and may deter a bystander 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/min with compression depth 4–5 cm and release of all pressure between compressions. This is tiring and much research has been conducted to develop practical mechanical devices to deliver repetitive, effective, chest compressions. The use of one such automated device was associated with improved survival after out-of-hospital cardiac arrest.[4]

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. Ventilation should include an 'inspiratory' phase lasting 1 s with enough volume (often only 500–600 ml) to make the chest rise. Wherever possible, supplemental oxygen should be used. Excessive ventilation increases intrathoracic pressure, decreases venous return and reduces coronary and cerebral perfusion. At the recommended rate and ratio of compression and ventilation, 2 min of CPR will contain approximately five cycles.

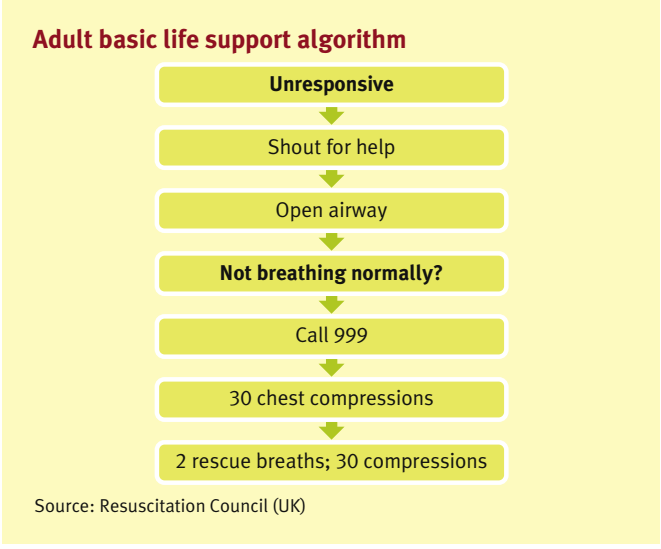

Figure 1

Hands-only CPR

Ramaraj and Ewy have recently reviewed a number of clinical trials, which suggest that resuscitation techniques using continuous chest compressions alone – CCC-CPR – are at least as effective as those using cycles of compressions and ventilation.[5] They argue persuasively that, soon after witnessed cardiac arrest, the emphasis should be on 'hands-only' CPR and that during this time (in this patient group at least) the provision of ventilation is counterproductive and the term 'rescue breathing' is a misnomer.

To balance this enthusiasm, it should be recognized that 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 may be life-saving in their situation.

Advanced life support

Notwithstanding these recent developments, the existing algorithm for advanced life support (ALS)[3] is shown in Figure 2. If the collapse is witnessed and VF confirmed, a precordial thump is acceptable if a defibrillator is unavailable. 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/min) should continue uninterrupted and ventilation (10/min) should be sufficient to observe the chest rising. Ventilations and compressions may then be non-synchronized.

Chest compressions are interrupted only to allow assessment of cardiac rhythm (as 'shockable' – VF or pulseless ventricular tachycardia – or 'non-shockable') and defibrillation. Adhesive electrodes are placed without stopping CPR, the 'right' electrode being placed to the right of the sternum just below the clavicle and the 'left' electrode as far into the left axilla as possible, and not over breast tissue. It does not matter if the electrodes are reversed. An analysis of cardiac rhythm should be performed immediately and a single shock delivered if advised. CPR should resume immediately without a rhythm check and, unless signs of life become apparent, should continue for 2 min before reassessment of cardiac rhythm and (if organized electrical activity appears) a check for a palpable pulse. Repeated shocks without interposed cycles of CPR are not advised. Thus, following 2 min of CPR, if a shockable rhythm persists, a second shock should be delivered (150–360 J biphasic) and CPR resumed. This 'single-shock sequence' significantly reduces time without chest compressions during resuscitation. It is even possible that chest compressions might safely be continued during defibrillation – the electrical current that passed through (or was perceived by) rescuers who placed a gloved hand on patients' chests during biphasic shocks of 100–360 J was insignificant.[6]

Neither vasopressors nor anti-arrhythmic drugs given during resuscitation have resulted in long-term benefit, yet such drugs, delivered into a proximal vein, are included in the algorithm. Adrenaline (epinephrine) 1 mg IV is recommended just before the third shock in cases of resistant VF and every 3–5 min thereafter (i.e. before alternate shocks). Adrenaline is also recommended as soon as possible in cases of asystole or PEA, and every 3–5 min thereafter (i.e. after every 2-min cycle of CPR). Amiodarone 300 mg bolus IV injection should be given just before the fourth shock in cases of resistant VF, and further