HEART DISEASE

(9) CARDIOPULMONARY RESUSCITATION

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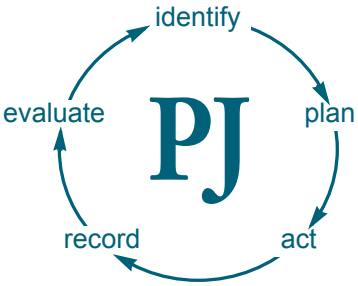
This article is the last in a series on heart disease. It is intended as a reminder to pharmacists who have completed a basic life support course. It is also intended to give an awareness of advanced life support procedures and how some pharmacists may be involved



identify gaps in your knowledge

1. What is the most common cause of cardiac arrest?
2. How are cardiac arrests managed?
3. What is the ventilation to compression ratio for basic life support?

Before reading on, think about how this article may help you to do your job better.

The Royal Pharmaceutical Society's areas of competence for pharmacists are listed in "Plan and record," (available at: www.rpsgb.org.uk/education). This article relates to "common disease states and their drug therapies" (see appendix 4 of "Plan and record").

Sudden cardiac death is a major cause of mortality in the United Kingdom. In addition to those in hospitals, 12,000 people a year suffer a cardiac arrest in a public place. The most common precipitating factor is cardiac arrhythmia. This article discusses the management of cardiac arrest in adults. For children and infants, the appropriate texts should be consulted. These can be found at www.resus.org.uk.

Cardiac arrest has been defined as "a cessation of effective cardiac output, due to arrhythmias, metabolic or mechanical events." Clinically, this presents as an acute loss of consciousness with an absence of any effective pulse or respiration.

The management of cardiopulmonary arrest can be divided into two categories: basic and advanced life support. All persons trained in these techniques should follow the recommendations of the UK Resuscitation Council. The first international set of guidelines for managing a cardiac arrest was published simultaneously in *Resuscitation* and *Circulation* in August 2000.[1] The UK Resuscitation Council published their interpretation of the guidelines in January 2001.[2]

Chances of surviving a cardiac arrest decrease rapidly with time. Survival rates are improved when the "chain of survival" is followed. The chain consists of four links:

Call for help → Basic life support → Defibrillation → Advanced life support

BASIC LIFE SUPPORT

Basic life support (BLS) is the "first responder" phase of the chain of survival. It can be carried out by anyone who has undertaken a basic first aid course. Most hospitals train staff in BLS skills. Community-based health professionals should ensure they are confident to handle a situation should it arise.

Many training schemes, such as Heartstart Emergency Life Support funded by the British Heart Foundation and others offered by British Red Cross and St John Ambulance are now available to members of the public, to facilitate BLS in the community. The aim is to recognise that a cardiac arrest has occurred, send for the emergency services and to maintain perfusion of vital organs until medical help arrives.

Before approaching the patient, the first aider should always check it is safe to do so. The patients should then be assessed to confirm that an arrest has occurred. This is done by checking the airway, breathing and circulation, sometimes referred to as "ABC".

The most common cause of cardiac arrest is the arrhythmia, ventricular fibrillation (VF), and all arrests are treated as VF until the patient can be medically assessed with an electrocardiograph (ECG). VF is known as a "shockable rhythm" because it responds to defibrillation. The main focus is on rapid defibrillation to sinus rhythm because the chances of survival decline by between 7 and 10 per cent for each minute the patient remains in VF. The guidelines therefore recommend a "first call strategy" where the emergency call is made before starting cardiopulmonary resuscitation (CPR). If an arrest is witnessed by an appropriately trained health professional and there is a delay obtaining the defibrillator, a pre-cordial thump (a sharp blow to the chest wall) should be administered. The kinetic energy imparted by the blow sometimes restarts the heart. It is not recommended that pre-cordial thumps are administered by members of the public.

CPR consists of ventilations and chest compressions, in the ratio of 2:15, to maintain perfusion of the vital organs. Without further treatment the heart will not restart. Chest compressions work to promote the forward flow of blood. They act as a cardiac pump (a direct compression of the heart) and a thoracic pump (an increase in intrathoracic pressure). When performed correctly, they provide only about 30 per cent of the normal cerebral perfusion. The guidelines for BLS are shown in Figure 1 (p582).

ADVANCED LIFE SUPPORT

Advanced life support (ALS) starts when medical personnel arrive. In hospital, ALS is provided by the cardiac arrest team and in a community setting it is provided by the paramedics. Regardless of the cause of the arrest the following occur:

- BLS is maintained
- The patient's airway is secured and oxygen is administered
- Intravenous (IV) access is obtained (in hospital, blood is taken for urgent blood gas analysis and electrolytes)

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- The patient's history is examined to try to identify the cause of the arrest

While this is happening, the patient will be attached to the cardiac monitor on the defibrillator, to allow diagnosis of the arrhythmia. Further management depends on whether or not the type of arrhythmia present will respond to defibrillation. Prompt identification and reversal of the cause of the arrest, if possible, is the key to successful resuscitation.

Arrhythmias responsive to defibrillation In addition to VF, pulseless ventricular tachycardia (VT) will respond to defibrillation and is also known as a shockable arrhythmia. The majority of cardiac arrests in adults are initially due to a shockable rhythm. In pulseless VT, the ventricles beat regularly but too fast to allow adequate filling between beats, so cardiac output is compromised. This may lead to the development of VF. In VF, the activity of the heart muscle becomes disorganised and cells no longer contract simultaneously, so again cardiac output cannot be maintained. During defibrillation, a high-voltage current is passed across the heart to stimulate co-ordinated cell activity and synchronised contractions to restart.

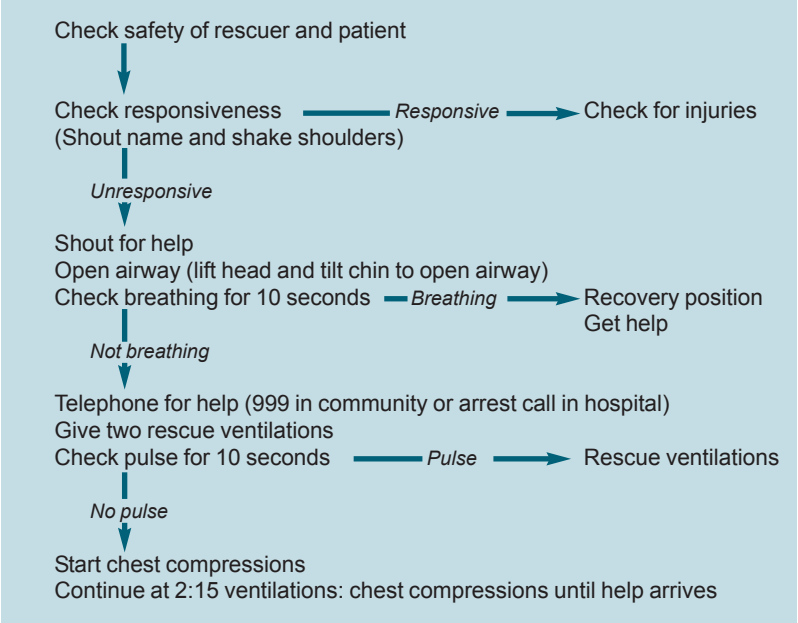

Figure 1: Guidelines for basic life support

Defibrillation is delivered in cycles of three shocks, known as "loops". The first two shocks are usually 200J and subsequent shocks are 360J. Since BLS cannot be performed during defibrillation (and oxygen cannot be delivered to the major organs), each loop should be completed within one minute. After the shocks are delivered it can take up to one minute to assess their effect. BLS should be stopped briefly to allow proper assessment of the underlying rhythm on the monitor. If a shockable rhythm remains, defibrillation can be repeated.

Arrhythmias not responsive to defibrillation Asystole and electromechanical disturbance (EMD) cannot be corrected using defibrillation. Asystole is the absence of any heart rhythm. EMD (also known as pulseless electrical activity) is the presence of organised electrical activity that is failing to result in mechanical contraction of the heart. If defibrillation attempts fail, an arrest originating with VT or VF will deteriorate to one of these rhythms with time.

Asystole should always be confirmed by checking that the ECG leads are positioned correctly and increasing the gain on the monitor. This ensures that VF is not misdiagnosed. CPR is maintained and rhythm and pulse are checked every three minutes. If asystole converts to a shockable rhythm (VF or VT), defibrillation will be carried out as described above.

Reversible causes of cardiac arrest In addition to VF and pulseless VT, other, less common reversible causes of cardiac arrest can be identified. If any of these are identified, prompt treatment may restore normal circulation. These causes can be divided into the 4Hs and the 4Ts: hypoxia, hypovolaemia, hypo- or hyperkalaemia and other metabolic disturbances, and hypothermia; tension pneumothorax (a continuous leak of air from the lung into the pleural cavity leading to increased thoracic pressure), tamponade (compression of the heart, usually by fluid in the pericardial sac), toxic/therapeutic overdose and thromboembolic and mechanical obstruction.

DRUG THERAPY

Basic CPR and early defibrillation are the only interventions proven to benefit survival in cardiac arrest. However, drugs also have a role and should always be considered. ALS should be maintained and adrenaline administered throughout the arrest. By administering drugs we aim to:

- Improve oxygen perfusion
- Enhance the defibrillation process
- Prevent recurrence of arrhythmias
- Increase cardiac excitability and contractility
- Correct metabolic disturbances
- Protect the cerebral and coronary circulation from the effects of ischaemia

In hospital, an "arrest box", containing a variety of drugs, is usually kept with the arrest trolley. Drugs in the arrest box tend to be either minijets, which require some degree of assembly, or, more commonly, pre-filled syringes.

Paramedics can administer adrenaline acid tartrate, bretylium, lignocaine hydrochloride, sodium bicarbonate and sodium chloride.

Drug administration IV access, if not already available, should be achieved as soon as possible. For IV administration, a flush of 20mls of sodium chloride 0.9 per cent should be administered after each drug dose to enhance its passage from the peripheral to the central circulation. Alternatively the dose can be given in tandem with a fast flowing IV fluid. This is a useful alternative in hypovolaemic patients.

In the rare situation where IV access is unattainable, a limited list of drugs may be administered down the endotracheal tube. However, larger doses (two or three times normal doses) are needed and absorption via this route is unpredictable. If the tracheal route is used, administration should be followed by five rapid ventilations to aid absorption.

Adrenaline Adrenaline (epinephrine) is the most common drug used in ALS. It is used to improve perfusion of the major organs during BLS. Blood flow is increased to the cerebral and coronary arteries by vasoconstriction of the peripheral vasculature through alpha-receptor blockade.

Current guidelines recommend the administration of 1mg of adrenaline IV every three minutes during resuscitation. If the rhythm is shockable, this should correspond to each loop of three shocks. Following each loop the need for a repeat dose of adrenaline should be reassessed once the rhythm status has been established. Doses above 1mg are no longer considered to be of benefit and should not be used.

Adrenaline can be given by endotracheal administration at a dose of 2 to 3mg diluted to at least 10ml with sterile water and, once given, should be followed by five inflations of the ventilation bag to aid absorption.

Atropine Atropine is often used in the management of asystole or bradycardia to block any excessive vagal activity that may be contributing to a reduction in heart rate. For asystole, a single 3mg IV dose is given. Higher doses have no benefit. Smaller doses (0.5–1mg IV) may be given in bradycardia to a maximum total of 3mg.

Amiodarone Amiodarone has replaced lidocaine as the anti-arrhythmic of choice in VF or pulseless VT. A dose of 300mg in 20ml glucose 5 per cent is given as a slow bolus over at least three minutes. A further bolus of 150mg can be given after 20 minutes if the arrhythmia persists. The guidelines suggest that the patient is then maintained on an infusion of 1mg/min for the next six hours, reducing to 0.5mg/min thereafter. A maximum daily dose of 2g is recommended by the international consensus guidelines for CPR, although it should be noted that in Europe the maximum licensed daily dose is 1.2g.[1] It should be remembered that amiodarone is incompatible with normal saline and bags of dextrose 5 per cent should be available to allow prompt setting up of the infusion and for flushing after dose(s).

Lidocaine Lidocaine can be used for the management of refractory VF or pulseless VT, but it is no longer recommended as a first line agent. It should not be given if the patient has already received amiodarone. When lidocaine is used, a weight-adjusted loading dose should be given initially, repeated after 10 minutes, if necessary, and then by infusion thereafter. It is important to ensure the rate of the infusion is slow or patients may start to show signs of central nervous system toxicity (nausea, visual disturbance and confusion).

Magnesium Magnesium is the agent of choice in torsades de pointes, a type of arrhythmia that is often drug-induced. It can also be useful in resistant arrhythmias especially if associated with hypomagnesaemia (more common in patient taking diuretics). A bolus of 8mmol is usually given. It is important to note that the effects of any non-depolarising muscle relaxant used (eg, during intubation or post-arrest) will be enhanced by IV magnesium and caution is required in renal impairment.

Sodium bicarbonate The use of sodium bicarbonate during an arrest remains controversial. If possible the underlying cause of the acidosis should be identified and corrected. However, it may become necessary to give sodium bicarbonate after a prolonged arrest if the patient becomes acidotic. This is usually due to a build-up of carbon dioxide during BLS. An increase in the rate of ventilations may help to correct this. Sodium bicarbonate should only be administered after arterial blood gas analysis where the pH has fallen below 7.1. A 50mmol (50mls of the 8.4 per cent solution) dose would normally be given as a slow IV bolus. Further administration should be guided by blood-gas results. It can also be useful in arrests due to tricyclic anti-depressant overdose or hyperkalaemia.

Other drugs Calcium chloride, procainamide and bretylium can also be considered. Calcium chloride may be especially useful in suspected or actual calcium channel blocker overdose. In refractory VF, procainamide is considered an alternative to amiodarone and lidocaine but, in practice, its use is limited because it needs to be given by slow infusion. Bretylium can be used for refractory ventricular arrhythmias. It is usually given as a weight-based bolus dose, repeated if necessary after 20 minutes and then followed by an infusion. It takes 20 minutes to see the anti-arrhythmic action and CPR will need to be maintained throughout this time. Calcium chloride may be used to correct actual or possible hypocalcaemia or hyperkaleamia. It can also be used in cases of calcium channel blocker overdose and in magnesium-induced heart block. Usually a dose of 10mls of the 10 per cent preparation is given. This contains 6.8mmol of calcium.

Post-arrest, the patient may need further supportive drug therapy, for example, inotropes such as dopamine and dobutamine.

THE ROLE OF THE PHARMACIST

The role of the pharmacist in resuscitation has traditionally been limited. In hospital, arrest boxes are usually filled and maintained by the pharmacy department. Some hospitals also have a pharmacist as a member of the resuscitation committee to advise when drug-related decisions are necessary. In community practice, up-to-date resuscitation skills and the confidence to use them may be called upon.

The concept of the pharmacist being an active member of the arrest team itself was first explored in the United States in the 1970s and was shown to be successful. It has been adopted by a small number of UK hospitals. The pharmacist attending the arrest has responsibility for the drugs used. Possible duties may include: preparing the medication, ensuring the appropriate medication and administration equipment is available and used optimally, recording the administration of drugs and other significant events (including timing of the events) and providing drug information as needed.[3,4]

action: practice points

Reading is only one way to do CPD and the Society will expect to see various approaches to CPD in a pharmacist's portfolio.

1. Consider taking a basic life support course, or, a revision course.
2. Find out if there is an AED near your place of work. Who is trained to use it?
3. Look at the UK resuscitation council guidelines.

evaluate

For your work to be presented as CPD, you need to evaluate your reading and any other activities. Answer the following three questions:

What have you learnt?
How has it added value to your practice? For example, have you applied this learning or had any feedback?
What will you do now and how will this be achieved?

THE FUTURE

Research into the management of the arrest situation centres around early CPR and defibrillation. To this aim, smaller and more portable defibrillators are being developed. Many are automated ("automated external defibrillators" or "AEDs") to allow non-clinical personnel to defibrillate a patient who is pulseless and unresponsive. The defibrillator analyses heart rhythm and decides whether or not a shock is necessary. In 1999, the Government set out a strategy to ensure wider public access to AEDs in order to improve outcomes in out-of-hospital cardiac arrests. The Department of Health has implemented the first two phases of this programme, which have resulted in 110 public places receiving 680 AEDs. Over 4,000 people have been trained in BLS and the use of the AED. It has been estimated that if half the patients suffering a cardiac arrest in a public place were to receive their first shock within four minutes, up to 400 lives might be saved each year.[5]

REFERENCES

1. The American Heart Association in collaboration with the International Committee on Resuscitation. Guidelines 2000 for cardiopulmonary and emergency cardiovascular care. An international consensus on science. Resuscitation 2000;46:1–448.
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4. Fielding S. The clinical pharmacist's role in cardiopulmonary resuscitation. Europ Hosp Pharm1997;3:105–7.
5. Woollard M. Public access defibrillation: a shocking idea? J Pub Health Med. 2001;23:98–102.

RESOURCES

- To find out more about dealing with medical emergencies, particularly in the out-of-hospital setting, read "Dealing with life-and-death emergencies". Pharm J 2001;266:361–3.