CME Article

Advanced Cardiac Life Support guidelines 2011

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ABSTRACT

The main emphasis in the Advanced Cardiac Life Support (ACLS) guidelines are in the areas of good quality chest compressions, ensuring normoventilation, removal of atropine from the cardiac arrest algorithm, removal of the use of the endotracheal route for drug administration, and renewed focus on the care provided after return of spontaneous circulation. In addition, the need for monitoring of quality of the various care procedures is emphasised. While the various ACLS procedures are being carried out, there is a need to minimise interruptions to chest compressions for maintenance of coronary perfusion pressures. In addition, the resuscitation team needs to continually look out for reversible causes of the cardiac arrest.

Keywords: Advanced Cardiac Life Support guidelines, cardiac arrest, chest compressions, drugs, reversible causes

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INTRODUCTION

Advanced Cardiac Life Support (ACLS), the fourth link in the chain of survival, is very dependent on the optimal conduct of the earlier three links in the chain, viz early access, early cardiopulmonary resuscitation (CPR) and early defibrillation, in order to attain good outcomes. One of the major changes over the years has been the introduction of post-arrest interventions into the ACLS guidelines. While arrhythmia management had been the cornerstone of previous ACLS guidelines, post-resuscitation interventions (i.e. measures carried out after return of spontaneous circulation [ROSC]) to sustain life and increase the chances of being discharged alive from hospital have gradually assumed increasing prominence. The 2011 ACLS guidelines address the following aspects of the vital fourth link in the chain of survival:

- Immediate actions following cardiac arrest
- Airway management
- Breathing (ventilation) issues
- Supporting the circulation during cardiac arrest
- Peri-arrest arrhythmias
- Identifying reversible causes
- Post-resuscitation care
- Organ donation

IMMEDIATE ACTIONS FOLLOWING CARDIAC ARREST

In most of our communities the majority of cardiac arrest events occur outside of a hospital. In the out-of-hospital environment, the emphasis would be on early recognition of cardiac arrest and access to the emergency medical system, the institution of prompt and good quality CPR by the first responder, administration of defibrillation, if indicated, and then moving the patient to the Emergency Department (ED) of a medical centre within the earliest possible time, usually by the crew of the local emergency ambulance service. Care provided by the emergency ambulance crew would usually be basic life support and defibrillation using automated external defibrillators. Increasingly, ambulance crew are performing a limited range of advanced life support procedures. Sometimes, collapsed patients are brought to hospitals in private cars or other vehicles without having had the benefit of many of the essential pre-hospital interventions.

Survival in patients of out-of-hospital cardiac arrest is critically dependent on prompt institution of the first three links of the chain of survival by community first responders and second-line ambulance crew. Prompt and appropriate action by these two groups would enable third-line responders, i.e. hospital staff, especially those working in EDs, to use the various components of the fourth link in the chain of survival to achieve a successful resuscitation. It is well known that survival in cardiac arrest is time-dependent. Survival decreases at a rate of 7%–10% with each passing minute[1] after cardiac arrest, if no acute interventions relevant to the first three links in the survival chain are implemented. The low survival rates currently seen in many communities reflect these gaps in pre-hospital care. Depending on the level of out-of-hospital resuscitation conducted, ACLS interventions carried out in the ED attempt to salvage as many of these patients as possible. The current survival rate of 2%–3% for all out-of-hospital cardiac arrest patients in Singapore reflects the need to better understand these gaps in the community. In addition, ensuring the best standard of ACLS in the hospital improves the likelihood of successful salvage of these patients.

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Most cardiac arrest patients who are managed in hospitals' EDs would have collapsed in the out-of-hospital environment. The small number who arrive alive at the ED usually collapse shortly after and would also be managed there, in which case, all the links of the chain of survival would have to be implemented promptly in order for the patient to have the best chances of survival.

A significant number of patients sustain cardiac arrest in the in-hospital environment. Ward patients may have had a period of deterioration and an unwitnessed arrest.[2-4] There could be significant variations in the time of recognition of these cardiac arrests in the hospital. Thus, it is important for there to be a system of early recognition of patients who are likely to collapse or have a cardiac arrest, through the use of early warning systems. For patients who collapse in the hospital, there is a need to ensure the following:

- Immediate recognition of cardiac arrest
- A system of calling for help within ward areas, ambulatory clinics and public areas of the hospital
- Immediate availability of staff to perform chest compressions and ventilation (with devices such as the bag-valve mask or pocket mask)
- Resuscitation equipment, including defibrillator, drugs and other devices, to be brought to the patient in the shortest possible time. The listing and layout for these should preferably be standardised within each institution.

Various institutions have introduced Medical Emergency Teams (MET), Cardiac Arrest Teams (CAT) or Code Blue Teams (CBT) to address the need to manage these arrests.[5-8] These institutions should have the ability to mobilise these teams promptly so that there could be better oversight and management of these resuscitations. However, it is also important to ensure that a strong foundation of good basic and advanced life support skills exists among all staff with patient care rights. An increasing number of hospitals are working toward ensuring that all their clinical staff are currently certified in basic life support and all doctors are trained and certified in advanced life support procedures and recertified on a regular basis.

AIRWAY CONTROL AND MANAGEMENT

An open airway is crucial for the delivery of oxygen to the lungs and tissues. Access to the airway must be ensured within a few minutes of the start of resuscitation. Training in airway management is essential so as to ensure that the resuscitation team is able to secure the airway early and manage the ventilatory aspects of the resuscitation optimally. Basic airway opening techniques, some or all of which may be used for the collapsed patient, include the following:

- Head tilt–chin lift: This remains the basic and initial airway opening manoeuvre. Other techniques commonly used and recommended include the classical or modified jaw thrust. Once opened, the airway needs to be cleared of secretions, usually with a blunt-tipped stiff suction catheter.
- Cricoid pressure: The routine use of cricoid pressure is not recommended.[9] While it may offer some protection from aspiration and gastric insufflation, it may also impede ventilation and interfere with intubation. If used, pressure should be adjusted, relaxed or released if it impedes ventilation or placement of an advanced airway.
- Oropharyngeal airways: This prevent the tongue from occluding the upper airway. It may be used in unresponsive patients (those with no cough or gag reflex), or during bag-mask ventilation.
- Nasopharyngeal airways: This may be used if a clenched jaw prevents insertion of the oral airway. It has been known to cause bleeding in up to 30% of instances[10] and should be used with caution in the presence of craniofacial injury.

PLACEMENT OF ADVANCED AIRWAY

As part of advanced airway management, it is crucial that all healthcare workers be proficient in the performance of airway opening and maintenance techniques. However, it must also be remembered that placement of an advanced airway may be associated with a number of potential risks, especially interruption of chest compressions. This would be less likely with the use of supraglottic airways. Thus, it is important to ensure SpO_2 and electrocardiogram (ECG) monitoring during placement of an advanced airway. Once the airway is in position and secured, the expected standards for confirming correct placement are: bilateral chest expansion; demisting of the endotracheal tube (ETT) during inspiration; five-point auscultation; continuous $ETCO_2$ measurement; and chest radiograph.

Endotracheal intubation performed by an unskilled provider can result in trauma to the oropharynx with occasional bleeding; long interruptions to compressions/ventilations with adverse impact on outcomes; hypoxaemia for prolonged periods, resulting in cerebral hypoxia; and failure to diagnose misplacement/displacement of the tube, which has been recognised in 6%–25% of instances.[11,15] Therefore, it is crucial that frequent training and retraining in these procedures are conducted so as to ensure that these skills stay current. Institutions will need to determine the frequency of such training and maintain the competence standards of physicians who are expected to perform advanced airway placement procedures.

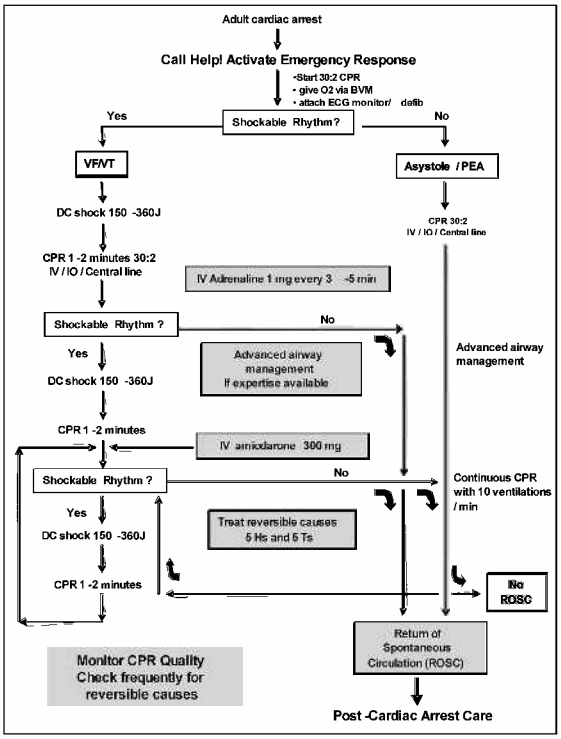

Fig. 1 Universal algorithm for cardiac arrest.

ETT placement has many benefits, such as allowing for a definitive patent airway, suction of secretions, reliable oxygen delivery and protection from aspiration of gastric contents. It would be indicated when there is inability to ventilate adequately with a bag-valve mask resuscitator, or if the patient is in a coma or cardiac arrest (absence of protective reflexes). Supraglottic airways, such as the laryngeal mask airway (LMA), combitube or the laryngeal tube, are alternative procedures that may be used, especially by pre-hospital care providers or by physicians if direct airway control is desired for short periods. The main advantages are that direct visualisation of the glottis is not required, and training and skills maintenance are easier.

BREATHING (VENTILATION)

The basic objective of ventilation in advanced life support is to ensure oxygenation of tissues. There is adequate evidence to demonstrate that ventilation, at least with passive high flow oxygen, leads to higher survival. Positive pressure ventilation, especially when associated with high tidal volumes and ventilation rates can potentially lead to increased intrathoracic pressures, decreased venous return and low cardiac output. The recommended rate of ventilation is ten breaths per minute, while the recommended tidal volume is 400–600 ml. If bag-mask ventilation (BMV) is being used, it is recommended that the user should compress the bag by about one-third,[16] which would be just sufficient to produce a chest rise over one second. If given in excess and at higher rates, BMV can result in gastric inflation (which would in turn elevate the diaphragm and restrict lung movement and chest wall compliance), regurgitation, aspiration and chest infection. Following insertion of an advanced airway device, it is recommended that continuous chest compressions be given with interposed ventilations once every 6–8 seconds (or about 8–10 breaths per minute).

CARDIAC ARREST MANAGEMENT

The principles of good resuscitation practice require clear emphasis. The foundations of advanced cardiac life support include the following:

Consistent performance of high-quality CPR

- Each compression to be at least 5 cm in depth and at a rate of 100 per minute, with complete chest recoil after each compression
- Minimise interruptions to chest compressions to the bare minimum
- Ventilating performed at 30:2 in the absence of advanced airway, and continuous chest compressions with ventilations interposed every 6–8 seconds with either an ETT or a supraglottic airway
- Implement monitoring of CPR quality as part of the culture of good resuscitation practice

Early defibrillation in the presence of ventricular fibrillation/pulseless ventricular tachycardia

- For monophasic defibrillation at 360 J per shock
- For biphasic defibrillation with an initial dose of 150 J with consideration for escalating higher energy defibrillation up to a maximum of 360 J, if desired.
- Every shock to be followed immediately by at least one minute of good quality CPR

An organised system of ACLS management

- Attention to team dynamics and organisation
- Careful use of drugs, especially adrenaline, amiodarone and other antiarrhythmic agents
- Constant attention to potential reversible causes of the cardiac arrest
- Maintenance of good basic life support practices during the phase of circulatory management

Integrated post-cardiac arrest care[17]

Principles of integrated post-cardiac arrest care are summarised in the universal algorithm for adult cardiac arrest (Fig. 1).

- In the event of ROSC, consider institution of measures that will minimise the likelihood of re-arrest and increase chances of survival and good neurological outcome.

- The components of post-ROSC care are incorporated in a bundle, which include the following: (a) therapeutic hypothermia at 33°C for at least 24 hours with gradual rewarming subsequently; (b) euglycaemic control; (c) prevention of hyperoxaemia; (d) early PCI after ROSC.

DRUG USE DURING CARDIAC ARREST MANAGEMENT

Drug therapy is not the primary form of management of cardiac arrest. The use of drugs in cardiac arrest patients is an adjunct to the earlier components of care, viz airway control and ventilation management, ensuring good quality chest compressions with minimal interruptions and prompt arrhythmia management. The following are special features concerning the use of pharmacological agents during cardiac arrest management:

Routes of drug delivery

- Peripheral large-calibre veins, especially the antecubital and external jugular veins, are the commonest routes used. CPR should be in progress so as to facilitate ease of identification and cannulation of these peripheral veins, which would tend to collapse in the absence of a circulation.
- Intraosseus (IO) cannulation using IO needles can allow drug delivery to the non-collapsible venous plexuses in the bone marrow. This may be resorted to if intravenous (IV) access is not easily available. The rates of drug delivery are expected to be similar to those for the IV route.
- Central venous lines either through the subclavian or internal jugular veins shorten medication access to the central circulation. In addition, the presence of a central line allows for measurement of central venous pressure to guide fluid resuscitation. Central lines, however, cannot be used for rapid infusion of fluids. The insertion of a central line is also likely to result in interruptions to chest compressions. It is important to be aware of the complications of central line insertion such as pneumothorax and bleeding into the pleural space.
- Endotracheal tube administration of drugs is no longer recommended, as the drug levels achieved are suboptimal and the doses required to achieve blood levels similar to the IV route are about 3–10 times as much.[18,19]

Circulation time during CPR

Circulation time during CPR is prolonged. Drugs need to reach the central circulation and the peripheral vasculature in order to exert their effects. This requires at least 30–60 seconds of good-quality chest compressions. Therefore, after each drug administration, the line should be flushed with 10–20 ml of normal saline and CPR continued for at least 30–60 seconds before the next shock is given, if required.

Common resuscitation drugs

- **Adrenaline** will continue to be administered at a dose of 1.0 mg and at a dilution of 10 ml (1:10,000 dilution) for bolus administration in asystole, ventricular fibrillation (VF) and pulseless electrical activity (PEA). When given as an infusion for bradycardic and hypotensive states, it may be infused at an initial rate of 2–10 μg/min and increased stepwise gradually until the desired heart rate is achieved.
- **Amiodarone** is recommended to be administered at a dose of 300 mg bolus in VF/pulseless ventricular tachycardia (VT). For presentations of haemodynamically stable VT with pulse, the recommended dose is 150 mg over ten minutes, which may be repeated once, and with conversion followed by infusion at 1 mg/min over six hours and then 0.5 mg/min over the next 18 hours.
- **Lignocaine** is initially given at a dose of 1–1.5 mg/kg/min bolus in the case of VF/pulseless VT, and at the rate of 10 mg/min in the event of stable VT. With successful conversion, maintenance infusions could be given at a rate of 30–50 μg/kg/min.
- **Adenosine** for supraventricular tachycardia (SVT) may be given as a rapid IV bolus of 6 mg initially. Failure of initial conversion should prompt a second dose of 12 mg bolus. Each bolus dose must be followed by a saline flush. The patient must be warned of side effects of transient chest tightness and hot facial flushes soon after drug administration. All such patients would require close haemodynamic monitoring.
- **IV verapamil**, a calcium channel blocker, may also be used for SVT as an infusion of 1 mg/min up to a maximum of 20 mg, with close haemodynamic monitoring at two-minute intervals. The infusion is stopped once conversion is achieved. In patients with fast atrial fibrillation, it may be used as a rate control agent when infused at the rate of 1 mg over three minutes up to a maximum of 20 mg, again with haemodynamic monitoring.
- **IV diltiazem** is an alternate calcium channel blocker. For patients with SVT, it may be infused at a rate of 2.5 mg/min up to a maximum of 50 mg, with close haemodynamic monitoring at two-minute intervals. The infusion is stopped once conversion is achieved. In patients with fast atrial fibrillation, it may be used as

a rate control agent when infused at the rate of 2.5 mg over three minutes up to a maximum dose of 50 mg, again with haemodynamic monitoring.

- **Dopamine** may be infused intravenously in states of haemodynamically significant bradycardia beginning at rates of 2 mg/kg/min and increasing stepwise to a maximum infusion rate of 20 mg/kg/min, above which the likelihood of peripheral and splanchnic vasoconstriction may be significant and undesirable.
- **Magnesium sulphate** would be indicated as an IV dose for patients with polymorphic VT associated with prolonged QT interval (torsades de pointes). It is given at a dose of 1–2 g over 15 minutes.

Drugs taken off routine use

- **Atropine** has been removed from the recommended list of pharmacological agents for the treatment of asystole and PEA. There is lack of evidence for its benefit for these conditions. Atropine, however, continues to be the drug of first choice for treatment of haemodynamically significant bradycardia. Although short-acting, it has been clearly demonstrated to improve heart rate and symptoms in such patients. It is given at a dose of 0.6 mg intravenously and may be repeated at 3–10 minute intervals up to a maximum dose of 2.4 mg. In patients requiring cardiac pacing as a result of severe atrioventricular block, atropine can be used as a temporising measure to keep heart rates up while preparations are being made for the pacemaker.
- **Calcium** administration for cardiac arrest is no longer recommended regardless of rhythm. However, in patients with hyperkalaemia, especially in the presence of ECG changes, IV calcium administration in the form of calcium chloride 5–10 ml over 2–5 minutes or calcium gluconate 15–30 ml over 2–5 minutes is recommended as a first line agent to stabilise myocardial membranes.
- **Bicarbonate infusion** as a routine agent in cardiac arrest is not recommended due to reported adverse events during therapy, including decreased coronary perfusion pressure, extracellular alkalosis, hypernatraemia, hyperosmolality and excessive production of CO_2 with its attendant intracellular acidosis. However, it may be used judiciously in severe metabolic acidosis, hyperkalaemia or tricyclic antidepressant poisoning. When used, the initial dose would be 1–1.5 ml 8.4% sodium bicarbonate per kg body weight. Repeated doses, if given, should be at half the initial dose and given only at least 10–15 minutes after the initial dose. Preferably, bicarbonate therapy should be guided by arterial blood gas measurements.

Table I. Reversible causes of cardiac arrest.

• Hypoxia	• Tension pneumothorax
• Hyperkalaemia	• Tamponade (cardiac)
• Hydrogen ion acidosis	• Toxic ingestions
• Hypovolaemia	• Thrombosis (pulmonary)
• Hypothermia	• Thrombosis (coronary)

The underlying cause of acidosis should be treated and the effects of this on acid-base status evaluated.

VF AND PULSELESS VT

The management algorithm for VF/pulseless VT is included in Fig. 1. For every cardiac arrest patient with either of these rhythms, CPR should be instituted immediately. Once the defibrillator pads or paddles are in place, defibrillation should be given at a dose of 360 J for monophasic shock and 150–360 J for biphasic shocks. When using biphasic shocks, it is currently recommended that the first shock should be in the range 150 J to 200 J. Following each shock, good quality CPR should be continued for 1–2 minutes before ECG analysis.

For refractory VF, depending on the capabilities of the defibrillator and the protocols of the institution, escalating higher energy shocks may be considered, if available. The drugs that may also be used in refractory VF/pulseless VT include adrenaline, amiodarone and lignocaine in the doses described earlier. While all these are going on, good quality chest compressions and ventilations must be continued. Successful conversion with ROSC should be followed by an infusion of either amiodarone or lignocaine in the doses recommended.

A single precordial thump may be considered only for witnessed cardiac arrests, if it can be given promptly and if a defibrillator is not immediately available for use.[20] It should not delay the institution of CPR or defibrillation. It is not recommended for unwitnessed arrests.

ASYSTOLE/PEA

The management for both asystole and PEA is very similar. Diagnosis of asystole is also contingent on there being an absence of breathing or pulse in an unresponsive patient if all the ECG leads are verified to be correctly connected. The basic principles for the management of these patients are as follows:

- Immediate application of good quality CPR, with monitoring of quality
- Rhythm checks every 2–3 minutes
- Administration of IV adrenaline 1 mg in 10 ml, repeated every 3–5 minutes
- Look for reversible causes, especially the five H's and five T's (Table I)

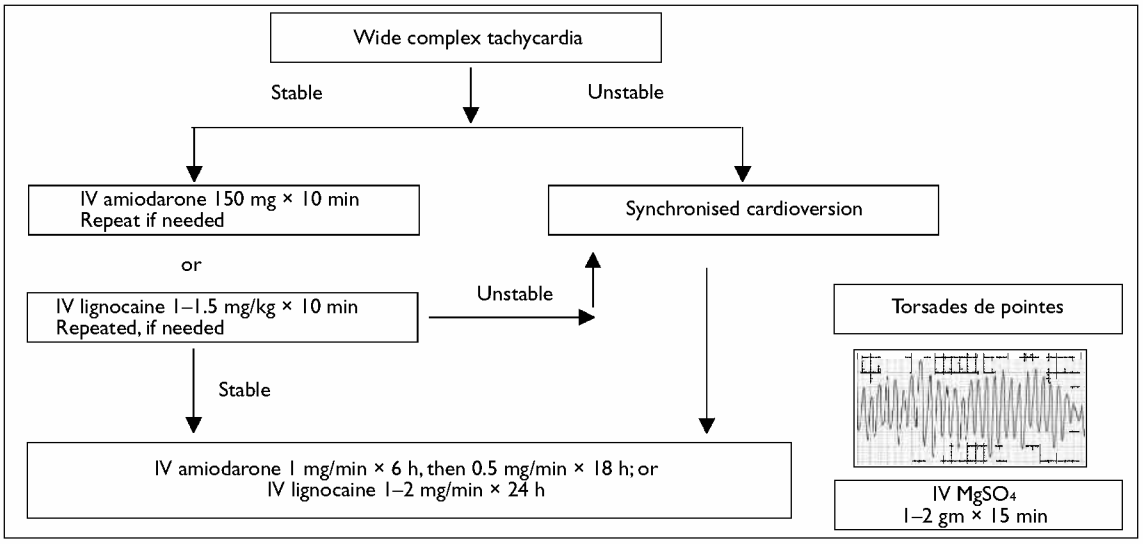

Fig. 2 Management of ventricular tachyarrhythmias.

- The five H's and five T's are applicable to all types of cardiac arrest and should be actively sought. Once the reversible factors are identified, immediate action would be required to correct these so as to provide the best milieu for a successful resuscitation.

NARROW COMPLEX TACHYARRHYTHMIAS

Patients presenting with SVT usually have sudden onset of symptoms. Diagnosis is made usually after a 12-lead ECG is performed. On attending to such a patient, the following will need to be carried out:

- The patient should be managed in a monitored area with vital signs and ECG monitors. Ensure that the airway is open and give oxygen if the patient is breathless or has oxygen saturation below 95%.
- Determine the patient's haemodynamic status. Patients whose blood pressure is below 90/60 mmHg or are very breathless or have altered mental state, signs of shock or acute heart failure should be deemed as unstable. These patients require synchronised cardioversion beginning at 50 J biphasic shock and prior sedation with IV midazolam.
- If vital signs are stable, non-pharmacological measures may be attempted initially, especially carotid sinus massage or the Valsalva manoeuvre. Failure of such manoeuvers means that drug administration would be required.
- IV adenosine, verapamil and diltiazem are all acceptable drugs of first choice for the conversion of stable patients with SVT.
- ECG and vital sign monitoring should be continued during the conversion process and for at least two hours thereafter for early detection of recurrence.

Patients presenting with fast atrial fibrillation also have potential for haemodynamic instability, and would need to be managed in a monitored area as follows:

- If blood pressure is below 90/60 mmHg or the patient is having altered mental state, signs of shock or in acute heart failure, he should be deemed as unstable. Synchronised cardioversion beginning at 50 J biphasic shock would be required, with prior sedation with IV midazolam and transesophageal echocardiography to rule out atrial thrombi. Prior administration of heparin would also be required.
- For rate control, if the patient is not having heart failure, calcium channel blockers such as verapamil or diltiazem given as slow infusion would usually be effective. For patients with heart failure, the current recommendation would be infusion of amiodarone 300 g over a 40-minute period, with frequent monitoring of blood pressure. IV digoxin 0.5 mg infused over 30 minutes would be an alternative.
- For rhythm control, IV amiodarone 150 mg administered over 20 minutes may be administered and repeated if there is failure of conversion with the initial dose. Monitoring of vital signs would be required during the infusion.
- The anticoagulation status of all such patients may need to be verified.

WIDE COMPLEX TACHYARRHYTHMIAS

The initial need is to determine whether the patient is haemodynamically stable. Those who are unstable would be presumed to have VT and thus require immediate synchronised cardioversion beginning at 100 J biphasic energy. If the patient is haemodynamically stable, a 12-lead ECG would initially be required (Fig. 2).

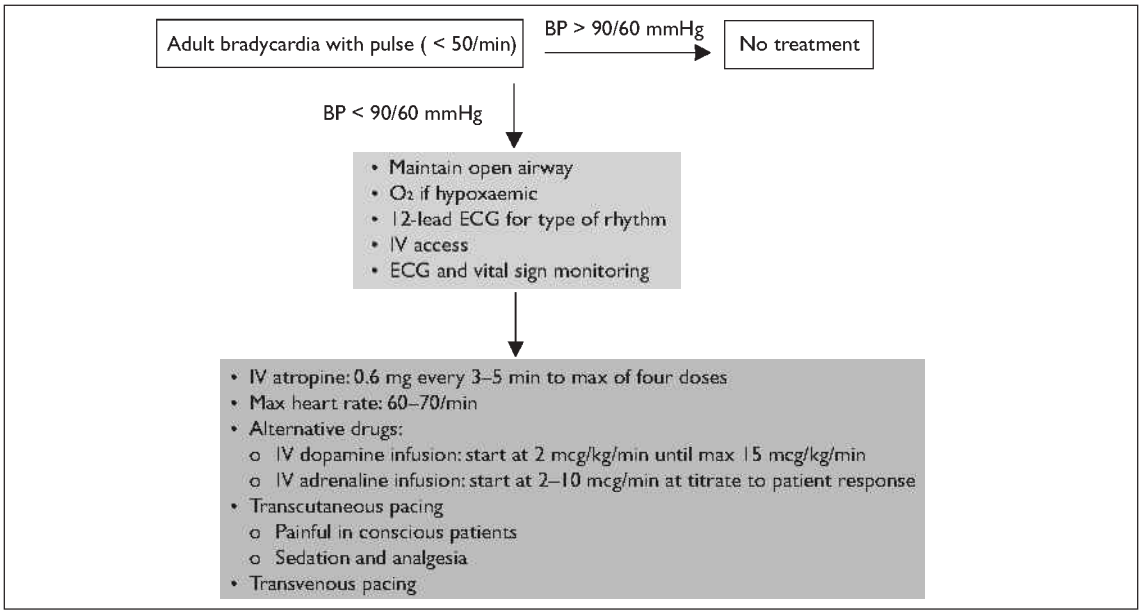

Fig. 3 Management of patients with bradycardias.

Patients with monomorphic VT would best be managed with IV amiodarone 150 mg given slowly over ten minutes and repeated if there is failure of conversion with the first dose. Alternatively, IV lignocaine at a dose of 1–1.5 mg /kg body weight may be administered at a rate of 10 mg/min and the dose repeated, if necessary. Patients who have known SVT with aberrancy may be treated as for SVT.

Patients presenting with polymorphic VT should usually be managed by electrical conversion. If the cause of the polymorphic VT is a long QT (torsades de pointes), IV magnesium sulphate 1–2 mg over a 15-minute period should also be administered so as to minimise the chances of recurrence. In patients with polymorphic VT and normal QT, interval IV amiodarone 150 mg given over 10 minutes may also be attempted and repeated if conversion is not achieved.

BRADYARRHYTHMIAS

Haemodynamically significant bradyarrhythmias usually present with a heart rate of below 60 beats per minute and a blood pressure of less than 90/60 mmHg. Most symptomatic patients tend to have heart rates that are even lower than 50 beats per minute. All such patients should be managed in a monitored area. Since hypoxaemia is common in bradyarrhythmic patients, all such patients would require 100% oxygen in the first instance. Ventilator assistance, if required, should be considered. Once a 12-lead ECG has been done and the rhythm causing the bradycardia determined, pharmacological therapy would be required (Fig. 3).

The common drugs that may be used for bradyarrhythmias are atropine, dopamine infusion and adrenaline infusion. Cardiac pacing should be considered for all patients with haemodynamically significant bradycardia. In an emergency situation, transcutaneous pacing (TCP) would be a reasonable option. It needs to be borne in mind that TCP is frequently painful in conscious patients. Preparation of the patient for TCP should also consider concurrent use of analgesics and sedation. TCP is, however, a temporary measure, and arrangements would subsequently be made for long-term transvenous pacing in such patients.

POST-RESUSCITATION CARE

The care of patients who achieve ROSC is described in detail in a separate paper. It forms an essential component of advanced life support.

ORGAN DONATION

There has been evidence[21-24] suggesting that the functional outcomes of organs from patients deemed to be brain dead due to cardiac arrest are not significantly different compared to those from donors who are brain dead not due to cardiac arrest. Many factors, including medical, social, cultural, legal and ethical issues, will need to be considered when embarking on a programme of using viable organs from patients who are brain dead as a result of cardiac arrest. This is an area that needs careful assessment. Potentially, it is an area for addressing the community's need for scarce organs.

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SINGAPORE MEDICAL COUNCIL CATEGORY 3B CME PROGRAMME
Multiple Choice Questions (Code SMJ 201108B)

	True	False
Question 1. Airway management techniques in non-trauma cardiac arrest include the following:		
(a) Modified jaw thrust followed by naso-gastric tube insertion.	☐	☐
(b) Head-tilt, chin-lift until ROSC is achieved before endotracheal intubation.	☐	☐
(c) Head-tilt, chin-lift and oropharyngeal airway insertion in initial phase of resuscitation.	☐	☐
(d) Cricoid pressure to ensure air enters the lungs and not the stomach.	☐	☐
Question 2. The following techniques are used for evaluating correct placement of the endotracheal tube:		
(a) Bilateral chest expansion on compressing the manual resuscitator.	☐	☐
(b) Misting of the endotracheal tube during the expiratory phase.	☐	☐
(c) Five-point auscultation of the chest and epigastrium.	☐	☐
(d) Continuous $ETCO_2$ monitoring.	☐	☐
Question 3. The following are components of post-ROSC care:		
(a) Gradual cooling to 33˚C over a 24-hour period.	☐	☐
(b) Maintaining blood sugar levels between 6–10 mmol/L.	☐	☐
(c) Maintaining SpO_2 levels at 100%.	☐	☐
(d) Arranging coronary revascularisation 24– 48 hours after ROSC.	☐	☐
Question 4. For drugs used in advanced cardiac life support:		
(a) The dose of adrenaline by the IV route is 1 mg diluted to 10 ml, and 2 mg if given by the intraosseus route.	☐	☐
(b) The recommended dose of amiodarone for ventricular fibrillation is 300 mg given over a 20-minute period.	☐	☐
(c) The infusion rate for calcium channel blockers in the emergency management of supraventricular tachycardia is 1 mg/minute of verapamil up to a maximum dose of 20 mg, or 2.5 mg/minute of diltiazem up to a maximum of 50 mg, until conversion occurs.	☐	☐
(d) Infusion of calcium chloride via an 8.4% $NaHCO_3$ solution is the initial treatment for hyperkalaemic cardiac arrest.	☐	☐
Question 5. In the management of wide-complex tachycardia:		
(a) Carotid sinus massage is used to exclude SVT with aberrancy.	☐	☐
(b) $MgSO_4$ 1–2 gm over 15 minutes is given for torsade de pointes.	☐	☐
(c) IV amiodarone 150 mg is infused over 10–15 minutes.	☐	☐
(d) A heart rate of 180 beats per minute with blood pressure of 80/56 mmHg is treated with synchronised cardioversion at 100 J.	☐	☐

Doctor's particulars:

Name in full: _____

MCR number: _____ Specialty: _____

Email address: _____

SUBMISSION INSTRUCTIONS:
(1) Log on at the SMJ website: http://www.sma.org.sg/cme/smj and select the appropriate set of questions. (2) Select your answers and provide your name, email address and MCR number. Click on "Submit answers" to submit.

RESULTS:
(1) Answers will be published in the SMJ October 2011 issue. (2) The MCR numbers of successful candidates will be posted online at www.sma.org.sg/cme/smj by 30 September 2011. (3) All online submissions will receive an automatic email acknowledgment. (4) Passing mark is 60%. No mark will be deducted for incorrect answers. (5) The SMJ editorial office will submit the list of successful candidates to the Singapore Medical Council.

Deadline for submission: (August 2011 SMJ 3B CME programme): 12 noon, 23 September 2011.