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European Resuscitation Council Guidelines 2000 for Adult Advanced Life Support

A statement from the Advanced Life Support Working Group [1] and approved by the Executive Committee of the European Resuscitation Council

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1. Introduction

The European Resuscitation Council (ERC) last issued guidelines for Advanced Life Support (ALS) in 1998 [1]. These were based on the 1997 International Liaison Committee on Resuscitation (ILCOR) Advisory Statements [2]. In 1999 and 2000 representatives of ILCOR, at the invitation of the American Heart Association, met on a number of occasions in Dallas to agree a Consensus on Science upon which future guidelines could be based. Representatives from the ERC played a prominent role in the deliberations, which culminated in the publication of The International Guidelines 2000 for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care — A Consensus on Science [3]. The consensus was evidence based wherever possible. The ERC ALS Working Group has considered this document and has recommended some changes in the guidelines that will be suitable for European practice. These changes, together with a summary of the Sequence of Actions in ALS, are presented in this paper.

The changes have also been incorporated into the curriculum of the ERC ALS provider courses and a new manual has been published to be used in all such courses from 2001 [4].

2. Summary of guideline changes

2.1. The precordial thump

A single precordial thump may be performed by professional healthcare providers, in a witnessed or monitored arrest before the defibrillator is attached and is therefore incorporated into the ERC ALS Universal algorithm. It is unlikely to be successful after more than 30 s of arrest.

2.2. The universal algorithm [5]

This is to be retained, in slightly modified form, for European practice in preference to the more complex versions chosen by some other countries.

The list of potentially reversible causes is retained (the '4 Hs and 4 Ts') and not expanded to five.

The four 'Hs'

- Hypoxia
- Hypovolaemia
- Hyper/*hypo*kalaemia, hypocalcaemia, acidaemia
- Hypothermia

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The four 'Ts'

- Tension pneumothorax
- Cardiac tamponade
- Thromboembolic or mechanical obstruction (e.g. pulmonary embolism)
- Toxic or therapeutic substances in overdose

2.3. Ventricular fibrillation (VF)/pulseless ventricular tachycardia (VT) [6]

The energy level and sequence of shocks is unchanged. Biphasic waveform energies of equivalent level are acceptable. The importance of early defibrillation is strongly emphasised (Class I).

Adrenaline (epinephrine) is given in a dose of 1 mg intravenously (IV) *or* 2–3 mg via the tracheal tube. Adrenaline has not yet been shown to improve outcome (Class indeterminate). High dose epinephrine is no longer recommended.

Vasopressin, in a single dose of 40 units, has been proposed as an alternative to adrenaline in VF/pulseless VT refractory to three initial shocks (Class IIb) but further evidence is required before this agent can be firmly recommended.

The evidence supporting the use of antiarrhythmic drugs in VF/pulseless VT is weak and no agent has been found which improves survival to hospital discharge rates. However, amiodarone should be considered, following adrenaline, to treat shock refractory VF/pulseless VT as early as after the third shock provided it does not delay further shock delivery (Class lIb). Amiodarone 300 mg (made up to 20 ml with dextrose, or from a prefilled syringe) may be given into a peripheral vein. A further dose of 150 mg may be required in refractory cases, followed by an infusion of 1 mg min^{-1} for 6 h and then 0.5 mg min^{-1}, to a maximum of 2 g (note that this maximum dose is larger than the current European datasheet recommendation of 1.2 g).

Magnesium (8 mmol) is recommended for refractory VF if there is a suspicion of hypomagnesaemia e.g. patients on potassium losing diuretics (Class IIb).

Lidocaine and procainamide (Class lIb) are alternatives if amiodarone is not available, but should not be given in addition to amiodarone. Procainamide is given at 30 mg/mm to a total dose of 17 mg 1 kg. The necessity for this relatively slow rate of infusion makes it a less favoured option.

Bretylium is no longer recommended.

2.4. Pulseless electrical activity (PEA)/electromechanical dissociation (EMD) [7]

If PEA is associated with a bradycardia (< 60/min) atropine, 3 mg intravenously or 6 mg via the tracheal tube, should be given. High dose adrenaline is no longer recommended (Figs. 1–3).

2.5. Asystole [8]

No significant changes in treatment. There is emphasis on careful confirmation of asystole before and after delivery of a shock. Guidance is given on the criteria to be satisfied and the timing before resuscitation is abandoned. High dose adrenaline is no longer recommended.

2.6. Airway Management [9]

Tracheal intubation remains the optimal method of securing the airway, but it is acknowledged that this is a very difficult skill to acquire and to maintain in the event of infrequent use. Reports of undiagnosed misplaced and displaced tracheal tubes are cited. Emphasis is placed on the need to confirm accurate tube placement. With a perfusing rhythm correct tube placement should be confirmed by a qualitative or quantitative measurement of end tidal CO_2 or by the oesophageal detector, in addition to the routine clinical methods (Class IIb). With a non-perfusing rhythm the oesophageal detector is a more reliable way of confirming accurate tube placement.

Acceptable alternatives to tracheal intubation, and bag–valve–facemask ventilation, include the Laryngeal Mask Airway (LMA) and the Combitube (Class IIa), especially for those who do not practice tracheal intubation frequently. The incidence of gastric regurgitation is very low with these devices and much less than with a bag–valve–facemask.

The technique of insertion with these devices is easier to acquire and the skill is well maintained. Correct training must be given to those who will use any airway device and the results should be audited.

2.7. Ventilation [9]

The tidal volume with a bag–valve–mask should be 700–1000 ml delivered over 2 s if the patient's lungs are being ventilated with air (sufficient to make the chest rise clearly). Once supplementary oxygen is available this can be reduced to 400–600 ml delivered over 1–2 s (sufficient to make the chest rise visibly). In the unprotected airway (e.g. with a bag–valve–facemask) smaller tidal volumes with oxygen supplementation can provide adequate oxygenation with a reduced risk of gastric inflation, regurgitation, and subsequent pulmonary aspiration. Until the airway is secured ventilation and chest compressions should be synchronised (a pause in the chest compressions to allow ventilation).

Once the patient's airway is secured, chest compressions should continue uninterrupted at a rate of 100 min^{-1}, (except for interruptions for defibrillation and pulse checks where indicated) and ventilation continued at approximately 12 breaths min^{-1}. Ventilation need not be synchronised with chest compressions as uninterrupted chest compressions result in substantially higher coronary perfusion pressures.

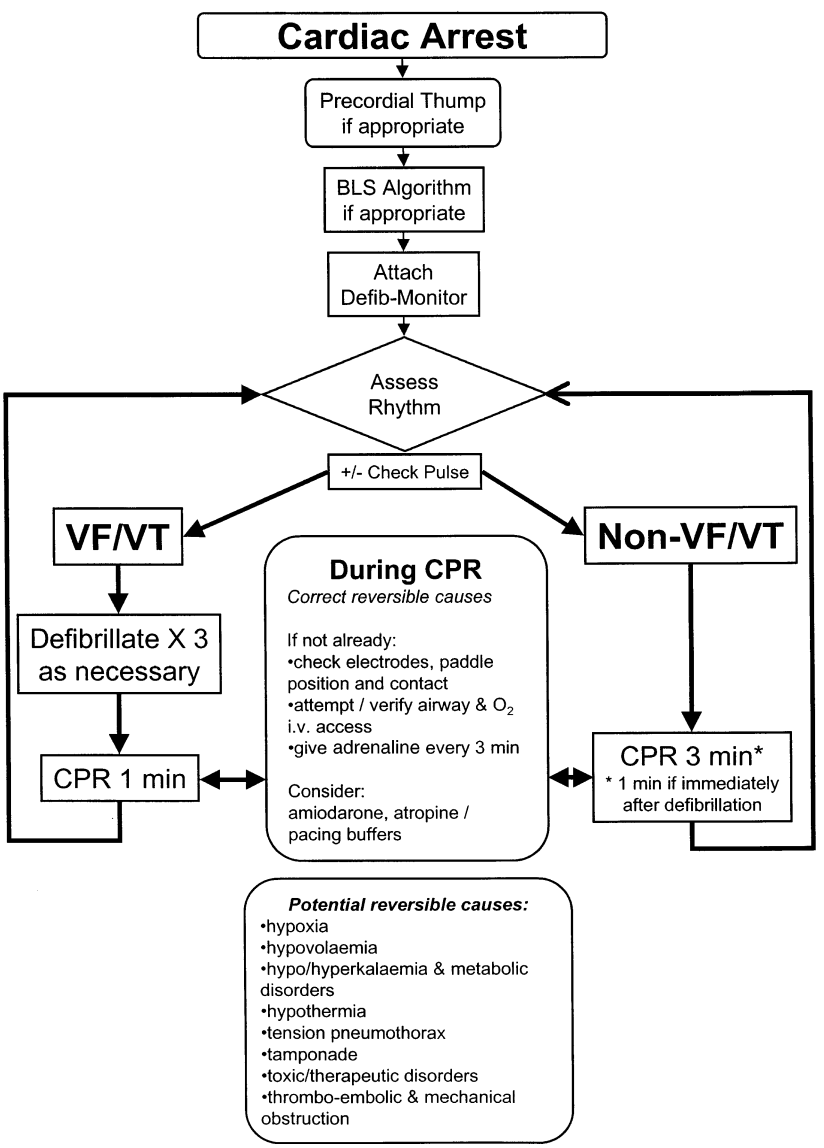

Fig. 1.

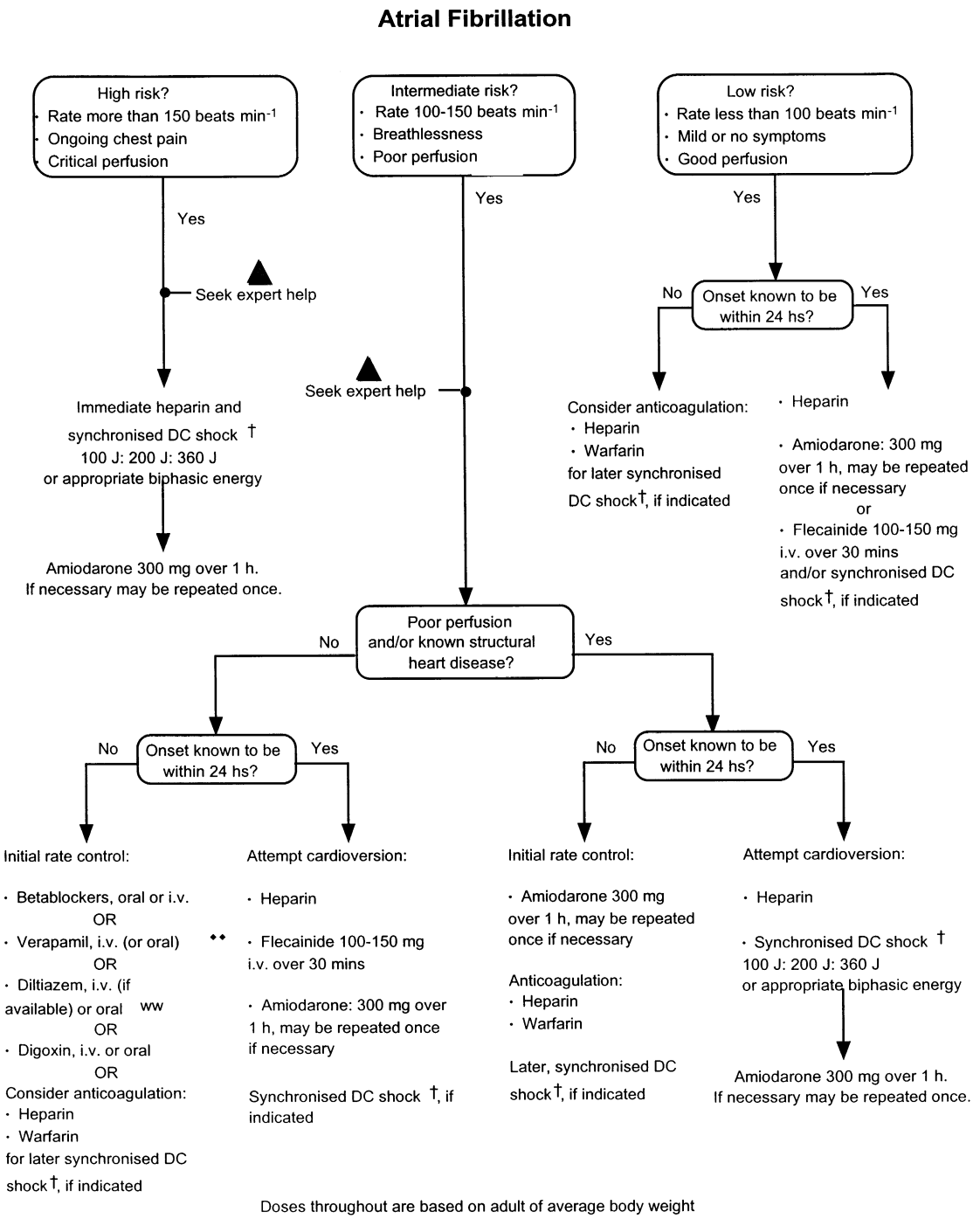
Atrial Fibrillation
High risk?
· Rate more than 150 beats min-1
· Ongoing chest pain
· Critical perfusion
Intermediate risk?
· Rate 100-150 beats min-1
· Breathlessness
· Poor perfusion
Low risk?
· Rate less than 100 beats min-1
· Mild or no symptoms
· Good perfusion
Yes
Seek expert help
Immediate heparin and synchronised DC shock † 100 J: 200 J: 360 J or appropriate biphasic energy
Amiodarone 300 mg over 1 h. If necessary may be repeated once.
Seek expert help
No
Onset known to be within 24 hs?
Yes
Consider anticoagulation:
· Heparin
· Warfarin
for later synchronised DC shock†, if indicated
· Heparin
· Amiodarone: 300 mg over 1 h, may be repeated once if necessary
or
· Flecainide 100-150 mg i.v. over 30 mins
and/or synchronised DC shock†, if indicated
Poor perfusion and/or known structural heart disease?
Initial rate control:
· Betablockers, oral or i.v.
OR
· Verapamil, i.v. (or oral) ◆◆
OR
· Diltiazem, i.v. (if available) or oral ww
OR
· Digoxin, i.v. or oral
OR
Consider anticoagulation:
· Heparin
· Warfarin
for later synchronised DC shock†, if indicated
Attempt cardioversion:
· Heparin
· Flecainide 100-150 mg i.v. over 30 mins
· Amiodarone: 300 mg over 1 h, may be repeated once if necessary
Synchronised DC shock †, if indicated
Initial rate control:
· Amiodarone 300 mg over 1 h, may be repeated once if necessary
Anticoagulation:
· Heparin
· Warfarin
Later, synchronised DC shock†, if indicated
Attempt cardioversion:
· Heparin
· Synchronised DC shock †
100 J: 200 J: 360 J
or appropriate biphasic energy
Amiodarone 300 mg over 1 h. If necessary may be repeated once.
Doses throughout are based on adult of average body weight
†Note 1: DC shock is always given under sedation/general anaesthetic.
wwNote 2: NOT TO BE USED IN PATIENTS RECEIVING BETABLOCKERS.

Fig. 2.

2.8. Circulatory adjuncts [10]

The following circulatory adjuncts are approved as alternatives to standard external chest compressions:

1. Active compression–decompression (ACD) CPR
2. Interposed abdominal compression (IAC) CPR
3. Vest CPR
4. Mechanical (piston) CPR
5. Direct cardiac massage CPR
6. Impedance threshold valve CPR

The use of all of these techniques is dependent upon comprehensive training being undertaken by all users. All are classed as IIb and await further evaluation.

2.9. Bradycardias [11]

The sequence of the ERC bradycardia algorithm has been modified slightly. Isoprenaline is no longer recommended; if external pacing is unavailable, a low dose adrenaline infusion is recommended instead.

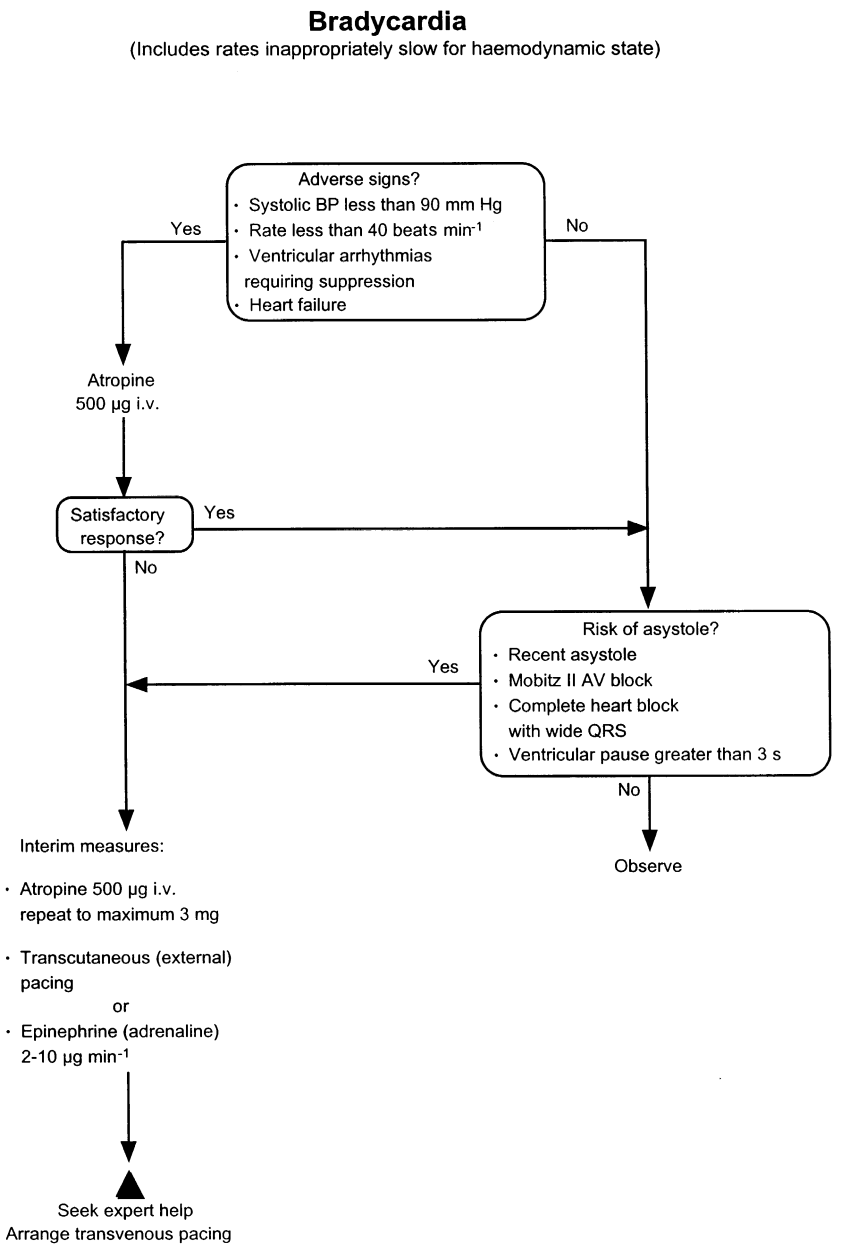

Fig. 3.

2.10. Tachycardias [12]

The ERC has not adopted the tachycardia algorithms published in the International Guidelines 2000. Instead, the existing ERC algorithms have been modified and an atrial fibrillation algorithm has been added [4].

Certain basic principles apply:

1. Immediate treatment will depend on whether the patient is stable or unstable (displays adverse signs).
2. Cardioversion is preferred when the patient is unstable.
3. All antiarrhythmic drugs have proarrhythmic properties.
4. The use of more than one antiarrhythmic drug is undesirable.
5. If a drug does not work, cardioversion should be considered the second antiarrhythmic.
6. If the patient has impaired myocardial function, most antiarrhythmic drugs will cause further impairment.

2.10.1. Atrial fibrillation and flutter

The patient is placed into one of three risk groups on the basis of heart rate and the presence of additional signs and symptoms. If the patient is in the high risk group attempt electrical cardioversion after heparinisation. The treatment options for patients at intermediate risk depend on the presence or absence of impaired haemodynamics or structural heart disease and whether the onset of the atrial fibrillation is known to be within the last 24 h.

Attempted cardioversion can be undertaken also in those patients in the low risk group where the onset of the atrial fibrillation is known to be within the last 24 h. In fibrillation of more than 24 h duration cardioversion should not be attempted until the patient has been anticoagulated for 3–4 weeks.

2.10.2. Narrow complex supraventricular tachycardia

If the patient is pulseless in association with a narrow complex tachycardia with a rate greater than 250 min^{-1}, attempted electrical cardioversion should be undertaken. Otherwise, vagal manoeuvres should be tried first (Valsava manoeuvre, carotid massage).

Adenosine is the first choice drug (Class IIa).

If the patient displays adverse signs, attempt electrical cardioversion, supplemented, if necessary, with amiodarone.

In the absence of adverse signs choose one drug from esmolol, verapamil, amiodarone or digoxin (Fig. 5).

2.10.3. Broad complex tachycardia

If there is no pulse follow the VF algorithm. If the patient displays adverse signs or the rhythm is unresponsive to drugs (amiodarone or lidocaine), attempt electrical cardioversion (Fig. 4).

2.11. Acute coronary syndromes [13]

This is a new section. Again the reader is referred to the full guideline text [3] and the ERC ALS Manual [4].

Certain general principles apply.

1. A 12 lead ECG should be available in the prehospital phase. ECG telemetry or computerised analysis may enhance prehospital diagnostic skills.
2. Facilities for immediate defibrillation and periarrhythmia control should be available.
3. In the absence of contraindications, all patients with isehaemic type chest pain should receive oxygen, opioids, and nitrates (Class I).
4. In the absence of contraindications all patients with acute myocardial infarction should receive aspirin and Beta blockers (the latter normally in hospital)(Class I)
5. Prehospital fibrinolytic treatment is beneficial when 'the call to hospital needle time' is greater than 60 min (Class I).
6. Angioplasty is an alternative to fibrinolytic therapy in centres with a high volume of patients and experienced staff (Class I).
7. Patients in cardiogenic shock should be considered for primary angioplasty and intraaotic balloon placement in suitably equipped centres (Class I).
8. Patients with non-Q-wave infarction and high risk unstable angina should be offered antiplatelet therapy with glycoprotein IIb/IIIa inhibitors. Antithrombin therapy with low molecular weight heparin may also be used in place of unfractionated heparin (Class Indeterminate).

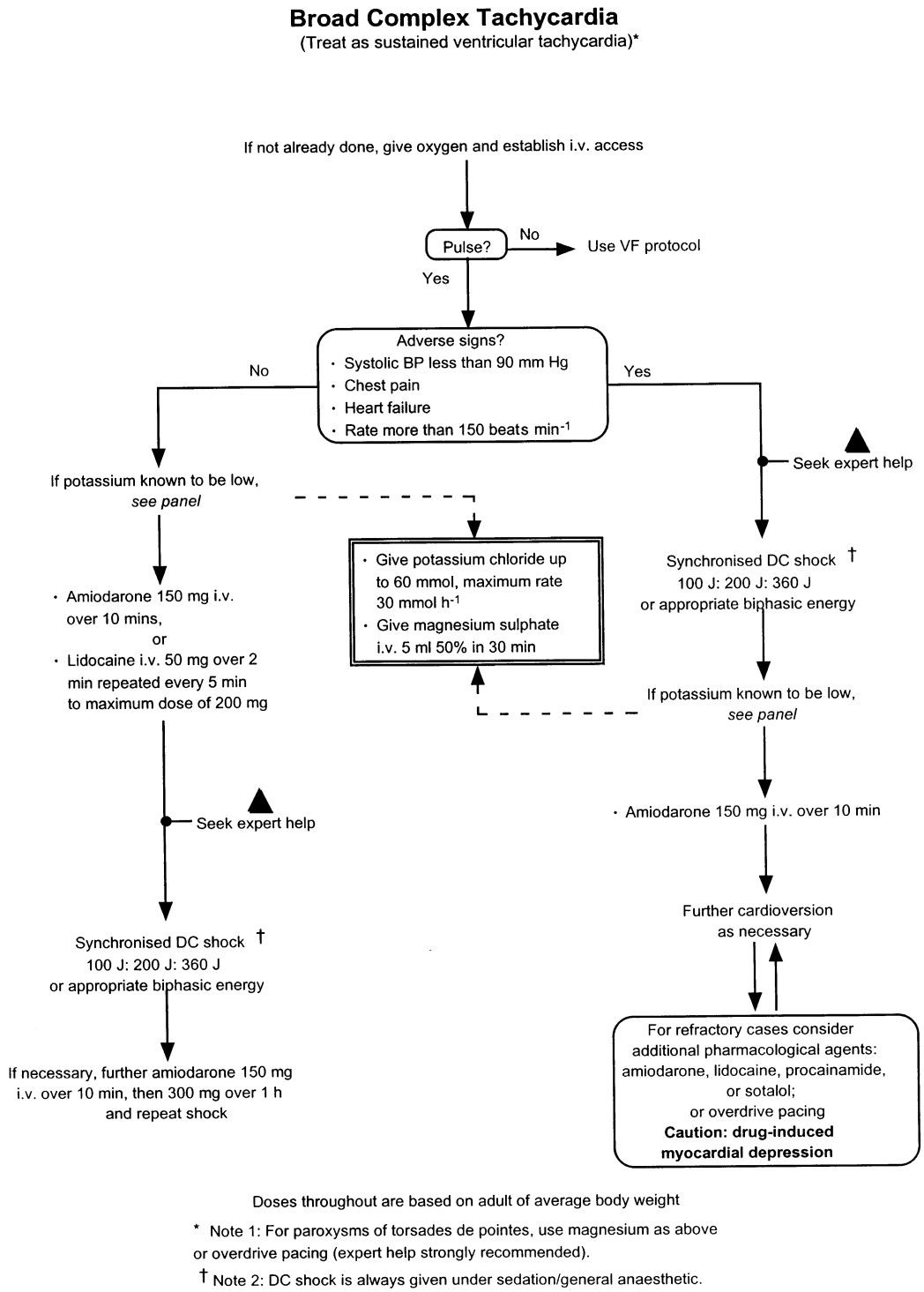

Fig. 4.

9. Patients with a large anterior infarction and/or impairment of left ventricular function should receive ACE inhibitors in the absence of compelling contraindications.
10. Glucose–potassium–insulin therapy may be beneficial in diabetic patients and those undergoing reperfusion therapy.

2.12. Postresuscitation care [14]

Patients who are mildly hypothermic ($>33°C$) after cardiac arrest should not be actively rewarmed (Class IIb). Febrile patients should be cooled and treated with antipyretics (Class IIa). Active hypothermia after cardiac arrest is under investigation (Class indeterminate).

After cardiac arrest, patients who require mechanical ventilation should have their $PaCO_2$ values maintained within the normal range (Class IIa). Hyperventilation, which produces $PaCO_2$ val-ues below normal may be harmful except in patients with cerebral herniation (Class III).

3. Sequence of actions

1. Precordial thump, if appropriate

If the cardiac arrest is witnessed or monitored, a precordial thump may be given before a defibrillator is attached. This is unlikely to be successful more than 30 s into the arrest.

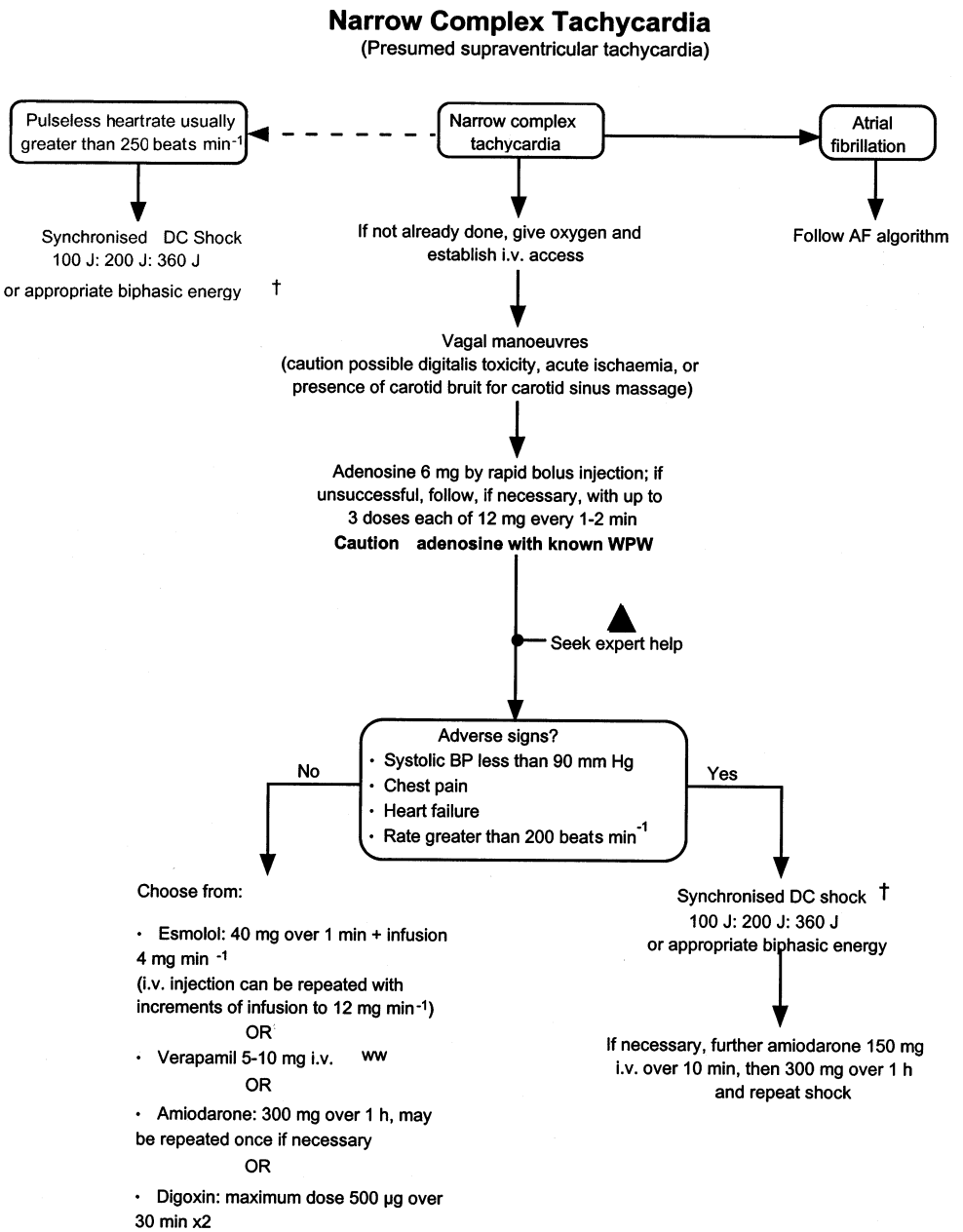

Fig. 5.

2. Establish basic life support, if appropriate

Basic life support should be started if there is any delay in obtaining a defibrillator, but must not delay attempted defibrillation. The priority is to avoid any delay between the onset of cardiac arrest and attempted defibrillation.

Use adjuncts for airway control and ventilation, provide positive pressure ventilation with a high inspired oxygen concentration, preferably 100%.

3. Attach a defibrillator–monitor

Monitor the cardiac rhythm:

- Place the defibrillator paddles or self-adhesive electrode pads on the chest wall; one just below the right clavicle, the other at the left mid axillary line.
- Place monitoring electrodes on the limbs or trunk but well away from the defibrillation sites.

To avoid delaying the first shock, the initial rhythm may be assessed through the defibrillation pads or electrodes. After a shock has been delivered there is a possibility of spurious asystole being displayed if monitoring is continued through paddles and gel pads. If a non-shockable rhythm is displayed via paddles and gel pads after the first or second shocks, monitoring leads should be attached, and the rhythm confirmed.

4. Assess rhythm ($\pm$ check for pulse)

Check for signs of a circulation, including the carotid pulse, but only if the ECG waveform is compatible with cardiac output.

- Take no more than 10 s

Assess the rhythm on the monitor as being:

- A shockable rhythm: Ventricular fibrillation (VF) or pulseless ventricular tachycardia (VT).
- A non shockable rhythm: Asystole or Pulseless Electrical Activity (PEA).

5A. VF/VT

(a) Ensure that everybody is clear of the patient.

Place the defibrillator paddles on the chest wall

Use up to three sequential shocks, if required, of 200, 200 and 360 J with a monophasic defibrillator, observing the ECG trace after each shock for any changes in the rhythm. Use appropriate alternative levels with a biphasic defibrillator.

The aim should be to administer up to three initial shocks, if required, in less than 1 min.

(b) If VF/VT persists after three shocks, perform 1 min of CPR (15:2).

(c) During CPR:

Consider and correct reversible causes. If not already:

Check electrodes, paddle position and contact.

Secure and verify the airway, administer oxygen, obtain IV access.

(Once the trachea has been intubated, chest compressions at a rate of 100 min^{-1} should continue uninterrupted, with ventilations performed at about 12 min^{-1} asynchronously)

- Give 1 mg adrenaline IV.

If venous access has not been established consider giving 2–3 mg adrenaline via the tracheal tube in a 1:10 000 solution.

- The interval between the third and fourth shocks should not be more than 1 min.

(d) Reassess the rhythm on the monitor.

Check for signs of a circulation, including the carotid pulse, but only if the ECG waveform is compatible with cardiac output.

(e) If the rhythm is non-VF/VT, follow the right-sided path of the algorithm.

(f) If VF/VT persists:

Consider amiodarone in VF/VT refractory to three initial shocks.

Attempt defibrillation with three further shocks at 360 J with a monophasic defibrillator or an equivalent energy for an alternative waveform defibrillator.

- Give 1 mg adrenaline IV.

The process of rhythm reassessment, delivery of three shocks and 1 min of CPR will take 2–3 min. One mg of adrenaline is given in each loop every 3 min.

Repeat the cycle of three shocks and 1 min of CPR until defibrillation is achieved.

(g) Each period of 1 min of CPR offers a new opportunity to check electrode/paddle positions and contact, secure and verify the airway, administer oxygen, obtain IV access, if not already done.

- Consider the use of other medications (e.g., buffers).

5B. Non VF/VT — asystole, pulseless electrical activity

(a) Check for signs of a circulation, including the carotid pulse.

(b) Perform, or restart, 3 min of CPR (15:2), if the patient is in cardiac arrest.

NB: If the non-VF/VT rhythm occurs after defibrillation, perform only 1 min of CPR before reassessing the rhythm and giving any drugs.

(c) During CPR:

Consider and correct reversible causes. If not already:

Check electrodes, paddle position and contact

Secure and verify the airway, administer oxygen, obtain IV access.

(Once the trachea has been intubated, chest compressions should continue uninterrupted, with ventilations performed at 12 min^{-1} asynchronously)

• Give 1 mg adrenaline IV.

If venous access has not been established, consider giving 2–3 mg adrenaline via the tracheal tube in 1:10 000 solution.

(d) Reassess the rhythm after 3 min of CPR.

Check for signs of a circulation, including the carotid pulse, but only if the ECG waveform is compatible with cardiac output.

(e) If VF/VT, follow the life-sided path of the algorithm.

(f) If non-VF/VT, perform 3 min of CPR (15:2).

• Give 1 mg adrenaline IV.

As the process will take 3 min, 1 mg of epinephrine (adrenaline) is given in each loop every 3 min.

(g) Each period of 3 min of CPR offers a new opportunity to check electrode/paddle positions and contact, secure and verify the airway, administer oxygen, obtain IV access, if not already done.

(h) Consider the use of other medications (atropine, buffers) and pacing.

6. Consider the use of other measures (medications and pacing)

(a) Antiarrhythmics

There is incomplete evidence to make firm recommendation on the use of any antiarrhythmic drug.

Amiodarone is the first choice in patients with VF/VT refractory to initial shocks. The initial dose is 300 mg diluted in 20 ml 5% dextrose given as an IV bolus. An additional 150 mg of amiodarone may be considered if VF/VT recurs.

Consider the use of amiodarone after three - shocks, but do not delay subsequent shocks.

(b) Buffers

Consider giving sodium bicarbonate (50 ml of an 8.4% solution) or an alternative buffer to correct a severe metabolic acidosis (pH < 7.1). When blood analysis is not possible, it is reasonable to consider sodium bicarbonate or an alternative buffer after 20–25 min of cardiac arrest.

(c) Atropine

A single dose of 3 mg of atropine, given as an IV bolus, should be considered for asystole and pulseless electrical activity (rate < 60 beats min^{-1}).

(d) Pacing

Pacing may play a valuable role in patients with extreme bradyarrhythmias, but its value in asystole has not been established, except in cases of trifascicular block where P waves are seen.

7. Consider/treat reversible causes.

In any cardiac arrest patient, potential causes or aggravating factors for which specific treatment exists should be considered:

Hypoxia
Hypovolaemia
Hyper/hypokalaemia
Hypothermia

Tension pneumothorax
Tamponade
Toxic/therapeutic disturbances
Thromboemboli

8. Advanced life support procedures

(a) Secure a definitive airway

Attempt tracheal intubation. When undertaken by experienced personnel, tracheal intubation remains the optimal procedure.

The laryngeal mask airway (LMA) or Combitube are acceptable alternatives to tracheal intubation when the healthcare providers have little experience with tracheal intubation and are well trained in the use of LMA and/or Combitube.

Verify the position of the tracheal tube or the LMA or Combitube at regular intervals.

(b) Establish ventilation

Ventilate the patient's lungs with 100% oxygen using a self-inflating bag with a reservoir or an automatic resuscitator.

(c) Establish vascular access

The central veins are the optimal route for delivering drugs rapidly into central circulation. However, these routes require special training and may have complications, some of which are potentially life-threatening. Peripheral venous cannulation is often quicker, easier, and safer to perform.

Drugs administered by this route should be followed by a flush of 10–20 ml 0.9% saline. When venous access is not available, (adrenaline atropine, and lidocaine only) may be given in the relevant tube. In this case, use higher doses (2–3 times) and dilute the drug in 10 ml of sterile water (or use the contents of appropriate prefilled syringes).

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