Cardiac arrest management:
NZRC guidelines 2006

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Despite many years of research into the mechanisms and management of sudden cardiac arrest, resuscitation remains an imperfect science. The problems involved in studying unexpected events, with ethical issues that make traditional randomised clinical trials difficult, conspires to make progress extremely slow. Despite this, every five years, the international resuscitation community evaluates all new evidence and puts forward recommendations to the world's resuscitation councils for modification of national resuscitation guidelines. The most recent evidence review took place in 2005 and as a result the New Zealand Resuscitation Council is introducing modifications to its collapse guidelines for both adult and child resuscitation.

It is important to understand that guideline change does not imply that old guidelines were wrong or dangerous, only that with greater understanding our priorities may need to change in order to extract the highest possible survival rate.

Compared to the old guideline, the new 2006 guideline differs primarily in the detail, not in overall substance. Both old and new guidelines clearly recognise the critical importance of early and effective CPR, early call for the emergency medical systems (111), early defibrillation in adults and early ventilation in children. However, there are several important themes that have influenced the 2006 guideline and mandates substantial modification to the previous guideline. These are the observations that:

- Survival rates are reduced if significant pauses occur in chest compressions during cardiopulmonary resuscitation. Studies have clearly demonstrated that frequent pauses for rhythm checks, pulse checks and ventilations decrease coronary perfusion and diminish the success of subsequent defibrillation. Therefore survival rates may increase if we decrease the hands off time during CPR and defibrillation.
- The success of defibrillation is not only determined by the collapse to shock time, but also by the interval between stopping chest compressions and delivering the shock. Defibrillation success might therefore improve if defibrillating shocks are delivered within seconds of stopping compressions.

These themes are reflected in the main changes to the 2006 guideline:

Guideline change does not imply that old guidelines were wrong or dangerous, only that with greater understanding our priorities may need to change in order to extract the highest possible survival rate

Chest compression/ventilation ratio

The old compression/ventilation ratio for CPR was 15/2 for adults and 5/1 for children. In 2006, in order to provide longer periods of uninterrupted chest compressions (i.e. to minimise the hands-off time) these ratios have been increased to 30/2 for adults and 15/2 for children. Compression rate remains (for children and adults) at 100/minute. As previously, once an endotracheal tube is in place, ventilations are given at a rate of 10 ventilations/minute (15 for children) with compressions being given continuously.

These compression/ventilation ratios are the recommendations for health professionals at NZRC level 4–6 (nursing) and level 7 (medical), however for laypeople (level 1–3) in order to make the recommendations as educationally simple as possible, the recommendation is a single 30/2 ratio for both adults and children. You may see the adult, child 30/2 recommendation in lay manuals and literature, but remember that for health professionals the adult and child recommendation is different.

Manual defibrillation

In the presence of ventricular fibrillation or ventricular tachycardia without a pulse, defibrillation is given using either an automatic external (AED), or a manual defibrillator. The recommendations for the shock sequence delivered by automatic and manual defibrillators is now different, and this recognises the long hands-off period required for the shock sequence in the majority of AEDs. The guideline changes for automatic external defibrillators are given at the end of this article.

Three major changes have been introduced to manual defibrillation in the advanced life support guideline:

- The recommended energy settings for adult defibrillation are the maximum capable of being delivered by the device, up to a maximum of 360 Joules. For children, the recommended energy setting is 4 Joules/kg.
- Defibrillations are delivered as 'rapid-fire' shock triplets.
- Defibrillation triplets are separated by two minute periods of CPR.

Energy settings

The shock delivered by different brands and model of defibrillator differ in the waveform of their delivered energy. According to the waveform shape they are called either monophasic or biphasic. The newer biphasic devices are capable of successfully defibrillating VF at lower energy settings than monophasic devices. Theoretically, therefore, the required energy for successful defibrillation may vary according to the device and its waveform. Because of lack of experimental evidence, we do not know the optimal setting for any particular waveform, although manufacturers do provide recommendations for their various devices. Because of the confusion that can occur where the type of defibrillator is not known by the rescuer, the NZRC has made the recommendation that the rescuer should simply deliver shocks at the maximum configured energy output of the device, up to a maximum of 360 Joules in adults, or in children give a standard energy of 4 Joules/kg.

Thus, for adult defibrillation a defibrillator capable of delivering only 200 J shocks would be used to deliver triplets of 200 / 200 / 200 J; a device capable of delivering up to 360 J would be used to deliver triplets of 360 / 360 / 360 J. The essential point to remember is that, for adults, whatever the device used, the rescuer simply turns the machine's energy setting up to the maximum it will deliver, up to 360 J. This recommendation applies to all manual defibrillators, both biphasic and monophasic.

'Rapid-fire shock triplets'

In the management of ventricular fibrillation and pulseless VT, the 2006 guideline recommends the delivery of defibrillations as 'rapid fire' shock triplets in which the rescuer attempts to:

1. Deliver, safely, three shocks as required, in as short a time as possible (certainly in no more than 30 seconds).
2. Ensure that the interval between stopping compressions and the first shock is as short as possible.
3. Ensure that following the third shock, the time to start chest compressions is as short as possible.

These conditions are met with the following recommended sequence:

- If the defibrillator incorporates adhesive electrodes, these are placed while chest compressions are being given. If manual paddle electrodes are used, these are placed on the chest immediately chest compressions are stopped.
- All rescuers are told to stand back and the defibrillator is immediately charged to its maximum energy output. As the defibrillator is charging, the ECG rhythm is quickly assessed.
- If the rhythm is not VF or VT the charge is dumped from the defibrillator and CPR is immediately resumed.
- If the rhythm is identified as VF or VT the first defibrillating shock is delivered. This should take place very quickly, between five and ten seconds after chest compressions cease.
- As soon as the first shock has been delivered, other rescuers are asked to remain standing back and the defibrillator is immediately recharged. As the defibrillator charges, there will be a few seconds in which the ECG trace stabilises. As soon as the defibrillator has been charged, and the rhythm

Key Points

The 2006 collapse guidelines for adults and children recommend that:

- CPR is given in a compression/ventilation ratio of 30:2 for adults and 15:2 for children.
- All manual defibrillations are given at the maximum output of the defibrillator (up to 360 Joules) in adults, and at four Joules / kg in children.
- Defibrillations are given as 'rapid fire' triplets separated by two minutes of CPR.
- The interval between stopping chest compressions and restarting chest compressions for defibrillation triplets should be no more than 30 seconds.
- Every effort is made to avoid hands-off time.

is seen to be VF or VT, a second shock is given. Then the defibrillator is recharged while rescuers are asked once more to keep back. In the same way the defibrillator is used to rapidly deliver the third shock if VF/VT remains present.
- Immediately following the third shock there is no reassessment of rhythm; immediately the shock is given, the paddles are removed and CPR is started.
- If, after the first or second defibrillation, the rhythm is observed to change to a rhythm other than VF or VT, the next charge is dumped from the defibrillator and CPR is immediately restarted. Thus even though the rhythm may have changed to sinus rhythm the pulse is not checked and CPR is continued.

Although it may appear incorrect to start CPR even though the rhythm has normalised, there are good theoretical reasons for doing this. Firstly little harm will come from giving CPR in the presence of a normal pulsatile rhythm, Secondly it is common for patients in VF to revert with defibrillation into a normal rhythm, but deteriorate quickly back into VF. However, by giving CPR immediately, it is thought that the compressions may generate sufficient coronary perfusion to supply the ischaemic myocardium with enough oxygen to prevent reversion; the rhythm is therefore more likely to be maintained in a pulse generating rhythm.

Two minute CPR intervals between shock triplets

The 2006 guideline has extended the period of CPR between shocks to two minutes. Previously CPR was given for one minute before the rhythm was rechecked or a shock triplet repeated. The longer period of CPR is recommended because if the first triplet was unsuccessful, this may imply poor myocardial oxygenation and, by giving a longer period of CPR, the improved oxygenation will increase the chances that the next triplet will be successful. Plainly this extended two minute period is extremely reliant upon good quality CPR.

Because CPR is resumed immediately after a third defibrillating shock the rescuer will not know whether the rhythm has become one that is pulse generating. If the casualty begins to rouse, the rhythm and pulse can be checked immediately, however if not, CPR is continued for two minutes. In these two minutes there will be four cycles of 30 chest compressions, and until an endotracheal tube has been placed, three pairs of ventilations.

ECG electrodes should be placed immediately after the first shock triplet or rhythm assessment through the paddles.

Only two drugs are now recommended as first line treatments during cardiac arrest management; amiodarone and adrenaline

Drug management

In addition to the changes to the defibrillation sequence and compression/ventilation ratio, significant changes have also taken place in the drug management for advanced life support. Only two drugs are now recommended as first line treatments during cardiac arrest management: *amiodarone* and *adrenaline*.

Adrenaline continues to be given to any casualty without a pulse generating rhythm, as an intravenous bolus dose of 1mg in adults, (10 microgram/kg in children), followed by a saline flush. The adrenaline is given during every second CPR cycle, i.e. every three to four minutes.

The recommended antiarrhythmic for VF/VT is ***amiodarone***, 300mg (5mg/kg in children) given as a rapid intravenous injection (not diluted in large volumes as recommended for normal antiarrhythmic therapy). It is given if the second shock triplet has been unsuccessful and the rhythm remains in VF/VT.

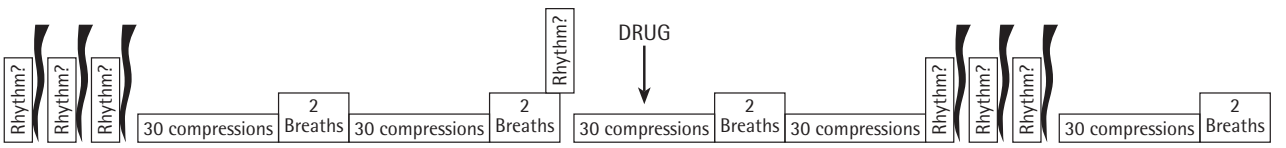
Vasopressin is no longer recommended as an alternative to adrenaline, and atropine is no longer recommended as a first line treatment for asystole.

When to give drugs

Because CPR is begun immediately after the third shock of each defibrillation triplet, it will not be known during the two minute CPR period whether the rhythm has changed from VF/VT. However, specific drug administration, and in particular amiodarone, must be based upon the rhythm present. If adrenaline or amiodarone is indicated during a CPR cycle, a very short pause to assess the rhythm should take place after about one minute of CPR. It should be stressed that this pause should be *as short as possible*.

Thus, after one minute of CPR (approximately two cycles of 30:2 CPR), pause for *no more than a few seconds* to determine the ECG rhythm. This pause should coincide with the

Figure 1. For VF/VT the sequence of defibrillations, compressions, ventilations, rhythm checks and drug administrations is summarised as follows:



pause for the two ventilations. If the rhythm is observed to be one that could be associated with a pulse, then feel for a pulse, otherwise *immediately* continue with chest compressions. If a cardiac arrest rhythm is present or some other rhythm is present but the pulse is absent, adrenaline 1mg should then be given. If the rhythm remains in VF/VT after the second shock triplet, amiodarone 300mg should be given as a bolus. Do not stop CPR to administer drugs.

For a summary of the sequence of defibrillations, compressions, ventilations, rhythm checks and drug administrations for VF/VT see Figure 1.

Consider the cause of cardiac arrest

Throughout a cardiac arrest victim's management it is important to recognise that the event will have had a cause. This cause is likely to persist once the initial arrest rhythm has been corrected, and may in fact prevent successful treatment of the arrest rhythm. During any cardiac arrest, irrespective of the ECG rhythm, always consider what has caused the cardiac arrest. Although a coronary syndrome is the most likely mechanism in adults, treatable causes could also include : Hypoxia, Hypovolaemia, Hyper/Hypokalaemia, Hyper/Hypoglycaemia, Hyper/Hypothermia, Tension Pneumothorax, Tamponade, Toxicity and Thromboembolism.

Cardiac arrest in children

As with previous childhood guidelines, the focus of collapse management in children is on early ventilation and oxygenation, hopefully before true cardiac arrest occurs. The new cardiac arrest guideline for children follows that of adult arrest management.

- The compression/ventilation ratio has increased from 5/1 to 15/2.
- Defibrillations are all given at energy settings of 4J/kg (i.e. energies are not escalated) and the same 'rapid-fire' method is used as for adults.
- There is a two minute CPR period between shock triplets.
- Drug administrations follow the same sequence as adults; amiodarone (5mg/kg) after the second shock triplet if VF/VT remains; adrenaline (10microgram/kg) during every alternate CPR cycle.

Automatic external defibrillators

Although automatic external defibrillation is an area of rapidly developing technology, the time taken to analyse the rhythm and fire three shocks is longer than that possible with a manual defibrillator used by a trained rescuer. The longer hands-off time for chest compressions is therefore an impediment to achieving higher survival rates. Although manufacturers are working on this problem, the AED cannot at present be viewed as a direct replacement for the manual defibrillator. It is better to think of the AED as a device enabling one to deliver a defibrillating shock as quickly as possible while a manual defibrillator is being obtained. A manual device is recommended for hospital use and for use by 24 hour emergency clinics.

Because the AED is considerably cheaper than manual defibrillators and the training necessary to use one is minimal, the automatic devices are useful at public venues, mass transit stations, corporate office buildings, shops, airlines etc. for use by lay people. Increasingly AEDs are also being purchased by out of hospital health professionals such as dental and medical practitioners where the present, but low likelihood of cardiac arrest management does not justify the cost of a manual device.

The recommended shock sequence for an AED is different to that for a manual defibrillator. This difference is because of the long hands-off time required for analysis and shock delivery of a shock triplet. Instead of giving defibrillations as triplets, the recommendation for new AEDs is that they deliver a *single* shock instead of a triplet, and allow immediate resumption of CPR (without a pulse check) for two minutes before the next reanalysis. This is called a 'single shock strategy'.

There are many makes and models of AED available and in use throughout New Zealand; some are monophasic, some biphasic and most older models will have been configured to deliver shock triplets. If you are using an unfamiliar device, you may not know which particular shock sequence the defibrillator has been configured to follow. Therefore simply follow the device instructions, irrespective of its particular configuration. It is suggested that owners of older AEDs consult with the manufacturer to look at the feasibility of reconfiguring the device to the single shock protocol. If this cannot be achieved, remember that it is better to use a defibrillator generating any shock sequence than to use no defibrillator at all.

If you are considering the purchase of a new AED it is recommended that the device:

- Delivers a biphasic waveform;
- Follows a single shock protocol;
- Is configured to deliver a shock of at least 150 Joules (remember that with a single shock protocol there is now only one chance of defibrillation every two minutes);
- Takes the least possible time between stopping compressions, delivering the shock and restarting chest compressions.

Competing interests

None declared.

*Further details and algorithm of the New Zealand Resuscitation Council advanced life support algorithm for adults and children is given at its website – **www.nzrc.org.nz***