



ST VINCENT'S
HEALTH AUSTRALIA
SYDNEY

UNDER THE STEWARDSHIP OF MARY AIKENHEAD MINISTRIES

ADULT
ADVANCED LIFE SUPPORT
GUIDELINES 2017



Don Harrison Patient Safety Simulation Centre

PREFACE

The International Liaison Committee on Resuscitation (ILCOR) regularly reviews research relevant to cardiopulmonary resuscitation and emergency cardiovascular care. It includes representation by the Australian and New Zealand Committee on Resuscitation, American Heart Association, European Resuscitation Council, Resuscitation Council of Asia and Resuscitation Council of Southern Africa.

The research reviews culminate every 5 years in Consensus on Science with Treatment Recommendations (CoSTR) documents. The most recent International Consensus Conference occurred in 2015 with publication of documents that can be viewed at www.ilcor.org.

The Australian Resuscitation Council (ARC) guidelines are informed by ILCOR via the Australian and New Zealand Committee on Resuscitation (ANZCOR). Updated guidelines have been published on Jan 2016 at www.resus.org.au.

This booklet is in line with ILCOR recommendations and ARC guidelines.

Patients referred to in this booklet are adult patients. Information about paediatric resuscitation can be sourced from the ARC.

THE DETERIORATING PATIENT

Research has found that an alarming number of in hospital cardiac arrest patients have had symptoms and signs outside normal parameters in the hours leading up to the arrest. These symptoms and signs include increased respiratory rate, oxygen desaturation, chest pain, tachycardia, hypotension, altered mental status and profound oliguria. Recognising these patients and initiating appropriate management may reduce the number of cardiac arrests on the hospital ward. This forms the basis of rapid response systems.

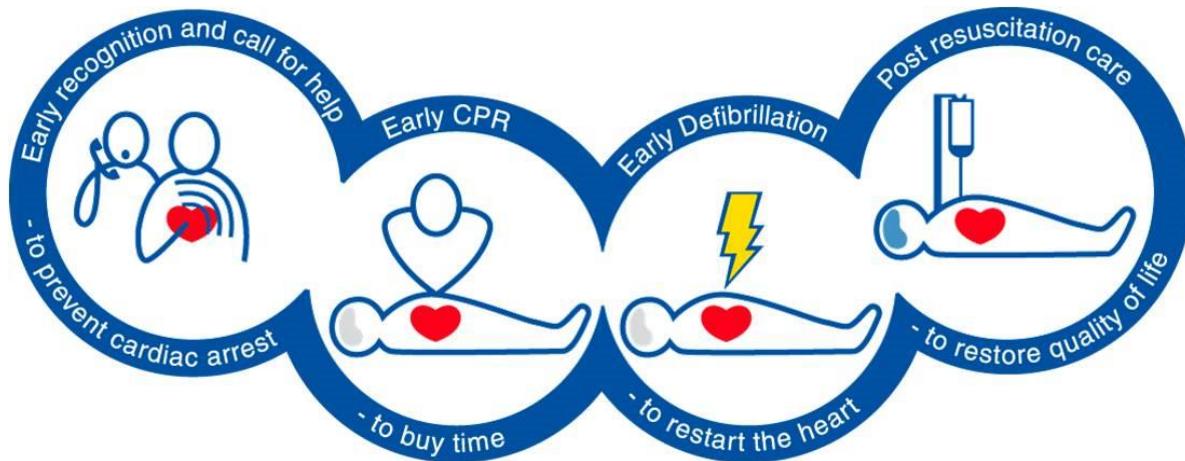
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INTRODUCTION TO ALS

Advanced Life Support (ALS) involves measures in addition to Basic Life Support (BLS) that promotes oxygenated circulation and interventions to obtain return of spontaneous circulation (ROSC).

Chain of Survival



The actions linking the victim of sudden cardiac arrest with survival are called the Chain of Survival. The links in the Chain of Survival are early recognition and calling for help, early BLS, early defibrillation, and early ALS with post resuscitation care. The most important determinant of survival from sudden cardiac arrest is the presence of a trained rescuer who is ready, willing, and able and equipped to act.

That's you.

BASIC LIFE SUPPORT

Detailed information can be found in the Basic Life Support Booklet. Points that warrant emphasis here are as follows:

- Defibrillation is performed as soon as possible.
- Effective and uninterrupted chest compressions are commenced immediately. The rate is 100 – 120/min and depth is 5cm or a third of the depth of the chest with full recoil between compressions. Depth and full recoil are just as important as rate.
- If an AED (automatic external defibrillator) is used, chest compressions need to pause while the AED assesses the rhythm. Chest compressions should recommence while the AED charges up, pause again briefly for shock delivery and then recommence immediately afterwards.
- Feeling for a pulse can be unreliable and may delay the commencement of chest compressions. Unresponsiveness and not breathing normally is sufficient evidence to start chest compressions.
- Give 30 chest compressions **before** giving 2 breaths via bag-mask or mouth to mask. If unwilling or unable to give ventilations, just give continuous chest compressions at 100 – 120/min.
- There needs to be a pause for 2 seconds after 30 compressions in order to deliver two breaths via bag/mouth to mask.
- If the patient is intubated, compressions are continuous. Ventilations are then delivered at no more than 10 ventilations/min and should be timed to occur during chest recoil.
- Performing effective chest compressions is tiring. Compressors should be changed at least every 2 minutes with minimal interruptions to compressions.

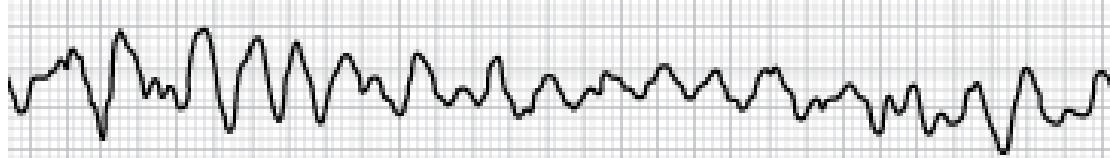
CARDIAC RHYTHMS

Rhythms in cardiac arrest can be simply divided into:

- Shockable
 - Ventricular fibrillation (VF)
 - Pulseless ventricular tachycardia (VT)
- Non-shockable
 - Asystole
 - Pulseless electrical activity (PEA)

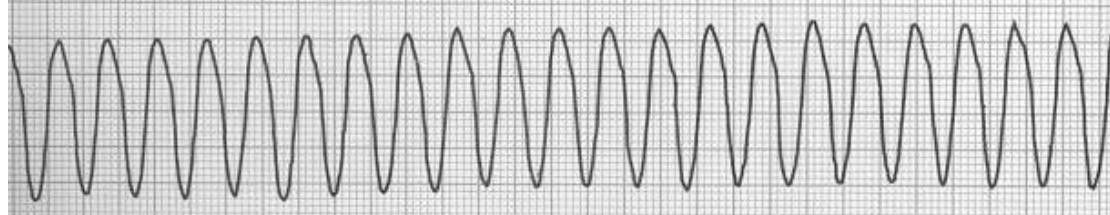
SHOCKABLE RHYTHMS

- Ventricular Fibrillation (VF)
 - Chaotic asynchronous electrical activity



VENTRICULAR FIBRILLATION

- Pulseless Ventricular Tachycardia (VT)
 - Wide complex tachycardia with no apparent cardiac output



VENTRICULAR TACHYCARDIA

NON-SHOCKABLE RHYTHMS

- Asystole
 - The absence of electrical activity (flat line).
- Pulseless electrical activity (PEA)
 - Any coordinated electrical activity where there is no cardiac output
 - Eg. Sinus tachycardia with no discernable pulse

DEFIBRILLATION

Early defibrillation for patients in a shockable rhythm is the single most important factor in improving survival.

Defibrillation depolarises a critical mass of myocardium so that pacemaker cells can take over with coordinated electrical activity. Defibrillation is part of BLS. Defibrillators are on all the arrest trolleys. Critical care areas and arrest teams carry a manual defibrillator. All other trolleys have an automatic external defibrillator (AED) so that all BLS trained staff can defibrillate the patient as soon as possible.

- The chance of successful defibrillation decreases rapidly with each passing minute, so defibrillation needs to occur as early as possible.
- Chest compressions are to recommence after every defibrillation irrespective of the resultant rhythm.

PAD PLACEMENT

RIGHT

PARASTERNAL
AREA OVER
2ND INTERCOSTAL
SPACE.



LEFT

MID AXILLARY LINE
OVER 6TH
INTERCOSTAL
SPACE.

- Imagine the patient's heart sitting as much as possible between the two pads.
- Pads can alternatively be placed antero-posterior, with one pad on the left parasternal area over the 2nd intercostal space and the other pad under the scapula in the left paraspinal area on the back.
- Pad 1 can be in Pad 2 position and vice versa.
- Pads adhere well, even to a very hairy chest. Clip hair only if necessary.
- Remove any underlying medication patches as they may block current delivery and cause burns.
- The same set of pads will remain effective for up to 40 shocks.
- The monitoring leads from the defibrillator only need to be attached for external pacing (in addition to the pads remaining in place.)

THE AUTOMATED EXTERNAL DEFIBRILLATOR (AED)



Apply the pads to patient

Press the green ON button

Follow the instructions

- The AED will request "Stand Clear" in order to analyse the rhythm. Any patient movement causes interference and "Stop motion" will sound.
- Once analysis has occurred, if a shock is advised, the AED will automatically charge up:
 - Chest compressions can be done during the charge up
 - For shock delivery:
 - Everyone must be clear of the patient
 - Free flowing oxygen held away from the patient
 - Press the RED shock button
 - Restart chest compressions immediately
(Unless there are obvious signs of life)
- If no shock is advised, restart chest compressions

The self-adhesive pads are the same for the AED and the manual defibrillator at SVH. Changing from an AED to a manual defibrillator only requires re-plugging the cord to the pads from one defibrillator to the next.

MANUAL DEFIBRILLATION

The manual defibrillator allows charging without rhythm analysis during chest compressions. Once it has charged, chest compressions can be paused so that the rhythm can be seen. If it is a shockable rhythm, the shock is ready to be delivered straight away, during the same pause in chest compressions. If it is not a shockable rhythm, the charge can be dumped by pressing the round speed dial at the bottom.



All defibrillators at SVH are biphasic. The recommended energy level for defibrillation is at least 200J. At SVH 360J is used. All subsequent defibrillations are at maximum joules. When the manual defibrillator is turned on, it should already be set at maximum joules (360J) so that no change to the energy level is required.

CHEST COMPRESSIONS RECOMMENCE AFTER EVERY DEFIBRILLATION

Successful defibrillation often does not result in effective cardiac output immediately. To reduce post arrest cardiac and neurological dysfunction, chest compressions are immediately restarted after defibrillation. Unless responsiveness or normal breathing becomes apparent (e.g. the patient starts moving, telling you to stop), continue chest compressions for the next 2 minutes. Then check the rhythm and feel for a pulse.

If a pulse is absent, the pulse is weak or there is uncertainty about the presence of a pulse, chest compressions are to continue. No more than 10 seconds should be spent feeling for a pulse. In the presence of a definite pulse, perfusion and blood pressure can then be assessed and further management provided as indicated.

EXTERNAL PACING

The manual defibrillator can provide external pacing. Pacing is only indicated for patients WITH cardiac output (i.e. a pulse) and a bradyarrhythmia where an increase in ventricular rate may improve cardiac output. Pacing asystole or pulseless electrical activity is futile and is not recommended.

The defibrillation pads remain in the same place as for defibrillation. The monitoring leads from the defibrillator have to be attached to the patient (there are 3; LA, RA, LL). There are 4 buttons on the defibrillator that relate to external pacing and they are located in the lower right hand corner, outlined by a green square (See above picture).

Press the pacer button to start and the light will come on. The rhythm will now read Lead II via the monitoring leads. Pointers above the patient's QRS complexes, indicate that they are being sensed, so that the pacemaker will not pace on top of these.

Select a rate by pressing either side of the rate button to go up or down. The default rate is 60/min but anywhere between 50 and 80 may be appropriate. Too fast is increased work for the heart and less time for coronary blood flow.

Then select a current. Default is zero; as soon as you register a current level above zero, this will be delivered to the patient at the rate you have selected. You will notice at a low current level, there are pacing spikes on the monitor, but no electrical activity in response to this. As you increase the amount of current, the pacing spike will be followed by depolarization of the heart, indicated by a wide QRS complex. **THIS IS ELECTRICAL CAPTURE**. The current level should be dialled up high enough to have electrical capture with every pacing spike. The amount of current required varies with many factors that affect impedance, such as patient size, body habitus, etc.

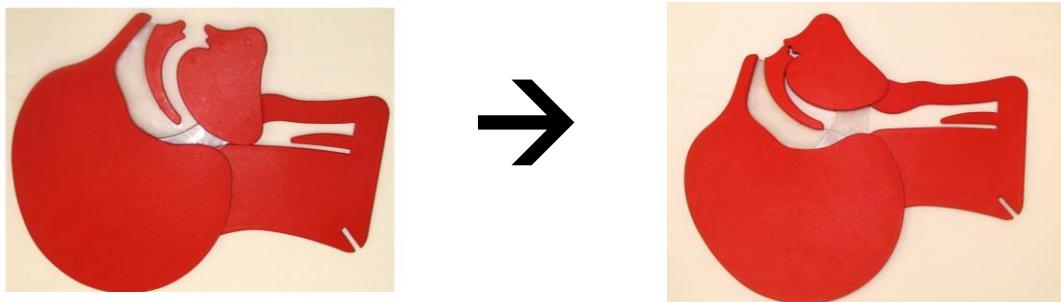
Once electrical capture is achieved, you need to ensure that the depolarization is actually causing the heart muscle to contract and generate a pulse. **THIS IS MECHANICAL CAPTURE**. It is possible to generate electrical capture without mechanical capture and this is of no benefit to the patient and pacing should be abandoned. If mechanical capture is achieved, the patient's blood pressure and perfusion needs to be assessed to ensure that the external pacing is providing some improvement.

External pacing is a temporising measure only, not definitive treatment. Conscious patients are likely to need analgesia and mild sedation to tolerate external pacing.

AIRWAY MANAGEMENT

AIRWAY MANOEUVRES

Head tilt, chin lift and jaw thrust open the airway by pulling the tongue off the back of the throat (oropharynx). In patients with suspected cervical spine injury, this is limited to jaw thrust. The airway can then be cleared of visible obstructing foreign material.



OROPHARYNGEAL (GUEDEL) AIRWAY

A Guedel airway sits behind the tongue to hold it off the back of the throat. Two Guedel airways (1 x medium 9cm and 1 x large 10cm) can be found in the top drawer of the arrest trolley.

The Guedel airway will only be tolerated in the deeply unconscious patient. It must never be forced in place. If the Guedel is not long enough to reach behind the tongue it will not be effective. If the Guedel is too long, it can touch the vocal cords and cause laryngospasm. Sizing can be approximated from the middle of the incisors to the angle of the jaw.

Insertion in adults (not children) is initially upside down (curved upwards) to get over the tongue. It is then twisted 180 degrees whilst advancing completely around the curve of the tongue. Jaw thrust while simultaneously completing insertion can help ensure the Guedel gets behind the tongue. If any resistance is met, or the Guedel obstructs the airway, it should be removed.

LARYNGEAL MASK AIRWAY (LMA)

A size 3 and a size 4 Classic LMA is a new addition to the top drawer of the standard ward arrest trolley. They are only to be used by trained staff. The LMA cuff sits on top of the larynx and offers better airway patency than a Guedel airway. The LMA is a reasonable alternative to intubation in cardiac arrest.

INTUBATION

Intubation of the patient may be attempted if there are sufficient resources and skill available. Intubation is not essential, and certainly does not take priority over chest compressions and defibrillation.

There are several benefits to having an endotracheal tube (ETT) in place:

Benefits

- Permits effective ventilation
- Chest compressions can be continuous 100 – 120/min
 - No need to pause after 30 compressions to deliver 2 breaths
- Protects the airway from aspiration
- Allows measurement of end tidal CO₂

Drawbacks

- Insertion requires a pause in compressions – MAXIMUM 20 seconds
- An incorrectly placed tube is worse for the patient than no tube at all

The most experienced airway person should intubate the patient. An arrest situation is not the time to learn how to intubate. If an intubation is difficult, it is preferable to return to bag-mask ventilation. Bag-mask ventilation is far better than an oesophageal intubation or an airway that is traumatised and potentially obstructed.

Correct ETT placement is crucial. Unrecognised oesophageal intubation worsens the patient's outcome. Objective measures of correct placement during an arrest are; seeing the tube go through the cords and detecting expired carbon dioxide. In cardiac arrest, pulmonary perfusion is low and so expired gas contains much less carbon dioxide than usual. This must be kept in mind when interpreting capnography. Listening to both sides of the chest verifies tracheal (as opposed to bronchial) placement of the endotracheal tube, i.e., that the tube hasn't been inserted too far.

WAVEFORM CAPNOGRAPHY

Expired CO₂ monitoring in the form of waveform capnography should be applied to all intubated cardiac arrest patients. It confirms, and then monitors, that the ETT is in the airway, rather than the oesophagus. It also allows monitoring of ventilation rate.

Systemic and pulmonary circulation is required to deliver CO₂ to the lungs for it to be expired. Capnography therefore provides feedback on the quality of CPR. The expired CO₂ level can jump up when spontaneous circulation returns. Likewise, loss of expired CO₂ can indicate a loss of cardiac output

VENTILATION

Ventilation during cardiac arrest can occur by:

1. Mouth to mask
2. Self inflating bag-mask
3. Bag and endotracheal tube (or other airway)

VENTILATION MASKS

There are masks with one-way valves in most clinical areas and in the top drawer of the arrest trolley at SVH. This enables mouth to mask delivery of expired air.

The masks are medium-sized to suit most patients and made of clear plastic. The valve port on the cuff of the mask is for cuff inflation (not for oxygen delivery to the patient). The pointed end of the mask is placed over the bridge of the patient's nose and then down the patient's face so that the lower edge sits between the bottom lip and the chin.

Valve port →
for cuff
inflation



Pressure needs to be applied between the face and the mask to obtain an airtight seal. The thumb and index finger are placed on the firm surface of the mask, either side of the universal port (to connect the ventilation bag or one way valve attachment). The three other fingers are placed along the mandible. The little finger can hook under the angle of the jaw if you are fortunate enough to have large hands, but this is not essential.

The mandible is then pulled up to the mask to apply pressure, rather than the mask pushed down on the face. This simultaneously opens the airway while achieving the face to mask seal, minimising inflation of the stomach.

THE SELF-INFLATING BAG

The bottom drawer of the arrest trolley contains a self-inflating (manual resuscitator) bag with a mask. This is a single-use adult size (1600mL) ventilation bag with a port for oxygen delivery and an oxygen reservoir. Oxygen flow should be high (10-15L) and sufficient to keep the reservoir bag inflated. Sufficient ventilation volume is enough to see the chest wall rise and is usually only a third of the bag size.

**BAG AND MASK VENTILATION IS A TWO-PERSON TASK
INFLATE JUST ENOUGH TO MAKE THE CHEST RISE**

A ventilation rate of 6-10/min is sufficient in a cardiac arrest



Over ventilation (>12 ventilations/min) may be harmful and should be avoided. It is associated with increased intrathoracic pressure and decreased coronary and cerebral perfusion.

Gas Trapping

Gas trapping can occur in patients with airway disease and the build up of intrathoracic pressure can halt circulation. A period of disconnection from the ventilation circuit during the resuscitation can release this pressure and permit return of circulation.

INTRAVENOUS ACCESS

Intravenous or intraosseous routes are used for drug administration in cardiac arrest. Perfusion is insufficient for intramuscular or subcutaneous drug absorption, so these routes are not recommended in cardiac arrest.

Insertion of a cannula into a large peripheral vein is a quick and easy way of obtaining intravenous access for the patient. If a central line is already in place it should be used. Insertion of a central line during an arrest may be difficult, risky (for patient and staff) and interfere with chest compressions and defibrillation so is not generally recommended.

Obtaining vascular access does not take precedence over chest compressions or defibrillation.

Use of the endotracheal tube to administer drugs is no longer recommended.

INTRAOSSEOUS ACCESS

When intravenous access is not attainable, the next best option for access is the intraosseous route. There are now intraosseous accessing devices that make accessing the adult intraosseous space simple and quick. An intraosseous drill is carried by ICU in the arrest pack and there is also one located in the Emergency Department.

The intraosseous space is effectively an intravenous space, so drug doses and concentrations are unchanged. The only difference is that drug and fluid administration will require pressure for administration. Intravenous fluid will require a pressure bag or hand pump.

More information <http://www.vidacare.com/EZ-IO/Index.aspx>

DRUGS

There is no drug therapy that has been shown to improve long-term outcome in cardiac arrest. Drug administration does not take precedence over chest compressions and defibrillation.

ADRENALINE

Presentation: Adrenaline 1mg in 10mL (1:10 000) ampoule

Adrenaline is given as a 1mg IV bolus every second cycle during an arrest. Adrenaline causes peripheral vasoconstriction thereby directing blood flow preferentially to the heart and brain. It is used to improve the oxygenation of these organs but must be accompanied by effective chest compressions and oxygenation. It is used during all arrests regardless of the rhythm or cause. Adverse effects include tachyarrhythmia, severe hypertension after resuscitation and tissue necrosis if extravasation occurs.

AMIODARONE

Presentation: Amiodarone 150mg in 3mL ampoule

Amiodarone 300mg IV is the anti arrhythmic of choice for VF/pulseless VT refractory to defibrillation. In the context of cardiac arrest, amiodarone 300mg is drawn up into 20mL of 5% glucose and given as a push. It has been shown to improve short-term outcome when compared to placebo or lignocaine. It is given after three unsuccessful shocks, leading up to the fourth defibrillation attempt. A further dose of 150mg may be considered after the 5th shock if there is subsequent defibrillation failure. Adverse effects include hypotension post resuscitation, bradycardia and heart block. Amiodarone is not kept on the general arrest trolley but will come with the arrest team.

ATROPOINE

Presentation: Atropine 600 micrograms in 1mL ampoule

Atropine does not have any role during cardiac arrest but is used in bradyarrhythmias. Atropine stops any vagal-induced bradycardia by blocking vagal innervation to the heart. The maximum effective adult dose is 3mg. Atropine is NOT to be used in heart transplanted patients (who lack vagal innervation to the heart) as it can cause high degree heart block.

CALCIUM

Presentation: Calcium chloride 10% (1g) 10mL vial

Calcium chloride has 3 times the concentration of Ca^{2+} ions than calcium gluconate and is the preferred method of delivering calcium in an arrest situation. It is indicated in arrest due to hypocalcaemia, hyperkalaemia and calcium channel blocker toxicity. Extravasation of calcium chloride can cause tissue necrosis.

GLUCOSE

Presentation: Glucose 50% in 50mL vial

Glucose IV is used for hypoglycaemia and patients with poor glycogen stores (e.g. alcoholic patients, cachectic patients).

INTRAVENOUS FLUIDS

0.9% sodium chloride is available in the arrest trolley as a 500mL bag. It can be set up with a blood pump giving set and used to flush through administered drugs.

LIGNOCAINE

Presentation: Lignocaine 500mg in 5mL ampoule

Lignocaine (1mg/kg) acts as an antiarrhythmic by blocking sodium channels. It is indicated for VF/ pulseless VT when amiodarone cannot be used. Adverse effects include seizures, bradycardia and heartblock. It is no longer kept on the general arrest trolley.

MAGNESIUM

Presentation: Magnesium 20mmol (5g) in 10mL vial

This is one adult dose in the context of cardiac arrest. Magnesium is not recommended for routine use. It does have a role in hypomagnesaemia, hypokalaemia, torsades de pointes, digoxin toxicity, sotalol toxicity and possibly refractory VF/VT. Excessive use may cause muscle weakness and respiratory failure.

NALOXONE

Presentation: Naloxone 400 micrograms/1mL ampoule

Naloxone is an antidote for respiratory arrest due to opiate overdose.

POTASSIUM

Presentation: KCl 10mmol in saline 0.29% in 100mL bag (pink)

Potassium is indicated for hypokalaemia ($K < 2.7 \text{ mmol/L}$).

SODIUM BICARBONATE

Presentation: Sodium Bicarbonate 8.4% in 100mL vial

Sodium bicarbonate is indicated in hyperkalaemia, tricyclic antidepressant overdose or severe pre existing metabolic acidosis. Routine use is not recommended.

REVERSIBLE CAUSES

The reversible causes are a list of factors that may be responsible for, or contribute to, the arrest. The reversible causes can be recalled as “the four Hs and the four Ts”.

THE FOUR Hs AND THE FOUR Ts

HYPOXIA

Hypoxia can be the precipitating cause of an arrest however all patients will become hypoxic after a period of not breathing. All arrested patients need as much oxygen as can possibly be delivered.

Oxygen delivery can initially take the form of expired air resuscitation in basic life support. There is a self-inflating bag in the bottom drawer of the arrest trolley. Connected to 15L oxygen, this allows delivery of up to 100% oxygen.

Patients who have arrested from hypoxia may have underlying reasons why ventilation is difficult. These patients may benefit from earlier intubation than other patients.

HYPOVOLAEMIA

Hypovolaemia causing arrest is commonly from haemorrhage. This may be bleeding in a postoperative patient, rupture of an abdominal aortic aneurysm, GIT bleed, a ruptured ectopic pregnancy or from trauma. Stopping the bleeding is essential to successful resuscitation. The fluid administered is ideally blood, preferably warmed through a rapid infuser (found in ED, OT, ICU). Blood administration via a pump set can be started straight away.

The postoperative patient may already have cross-matched units of blood. If there is no cross-match, unmatched Group O blood can be used. Ideally, it is Rh negative for female patients less than 45 years of age whose rhesus status is unknown.

Crystalloids or colloids can be used in resuscitation. Crystalloids can be 0.9% Sodium Chloride, Hartmann's or Plasmalyte. Avoid administering more than 1L of 0.9% Sodium Chloride as it contains excessive amounts of chloride, whereas Hartmann's and Plasmalyte do not. Colloids available include Gelofusine and normal serum albumin (NSA).

HYPO/HYPER K⁺/MG²⁺/CA²⁺/GLUCOSE

Electrolyte disturbance can cause cardiac arrhythmias and subsequent arrest. The potential for electrolyte disturbance can be sought from the patient's history. The patient may have had blood tests performed in the preceding hours that can be checked. Important electrolytes (e.g. potassium, calcium, glucose) can be checked during the arrest by blood gas analysis (venous or arterial).

↑K⁺ (*Hyperkalaemia*)

Hyperkalaemia can cause cardiac arrest and a level above 6.0mmol/L warrants treatment. Management of hyperkalaemia during a cardiac arrest differs from the non-arrest situation; medications need to have a rapid effect. Administration of calcium chloride lowers the resting potential of the myocardium and hence stabilises it. Sodium bicarbonate will push potassium back into cells reducing the circulating level. Both these treatments work within minutes and are available in the arrest trolley. Be sure to flush well with 0.9% Sodium Chloride between these medications to avoid precipitation of the calcium with the bicarbonate (chalk!).

↓K⁺ (*Hypokalaemia*)

Hypokalaemia can particularly occur in patients on diuretic therapy. A potassium level below 2.7mmol/L will cause ECG changes, so this is the level below which potassium should be administered during an arrest. Treatment is with pre prepared 100mL bags of KCl 10mmol in saline 0.9%. These bags have a pink plastic cover and are in the arrest trolley. Magnesium (20mmol in 10mL vial) should also be administered, as it will assist in correcting the hypokalaemia.

↓Mg⁺⁺ (*Hypomagnesaemia*)

Hypomagnesaemia is common in patients on diuretics, transplant patients, alcoholic patients and hypokalaemic patients. A magnesium level is not available on blood gas analysis but can be administered to patients suspected of having hypomagnesaemia.

↓Ca⁺⁺ (*Hypocalcaemia*)

Hypocalcaemia can occur in renal failure patients, post parathyroid resection and after receiving a large amount of citrate containing blood products. Ionised calcium level is measured by blood gas analysis. Treatment is with 10mL calcium chloride 10%.

↓Glucose (*Hypoglycaemia*)

Hypoglycaemia can cause cardiac arrest. Give 50mL Glucose 50% IV.

HYPOTHERMIA

Temperature is only relevant in arrest if the patient has a core temperature <30 degrees Celsius. Patients who are less than 30 degrees will need to be warmed up to this temperature if resuscitation is to occur. Defibrillation is less effective in patients less than 30 degrees, and should only be given once. Subsequent defibrillation attempts should wait until active rewarming brings the core temperature above 30 degrees. BLS continues during rewarming.

TENSION PNEUMOTHORAX

Increased air pressure in a pneumothorax pushes against the mediastinum, shifting it to the other side of the chest and kinking off the great vessels. This can stop blood entering and leaving the heart and so can cause cardiac arrest. It can be detected by feeling a shift of the trachea and the absence of air entry on ventilation of the affected side.

Releasing the pressure on the affected side of the chest immediately relieves tension pneumothorax. This is achieved by inserting a large bore cannula into the mid-clavicular line in the second intercostal space of the affected side. This is rewarded by the sound of air rushing out of the cannula, and hopefully, return of spontaneous circulation.

Risk of tension pneumothorax occurs in patients who have just had a procedure near the chest or upper abdomen (including central line insertion), trauma patients, asthmatics/airways disease and patients undergoing positive pressure ventilation. Intubation and ventilation of a patient during an arrest may precipitate a tension pneumothorax. Signs of tension pneumothorax should be repeatedly sought during arrest.

TAMPONADE

Rapid accumulation of blood or fluid in the pericardial space can compress the heart and compromise the circulation. This is called cardiac tamponade. Patients at risk include cardiothoracic surgery patients and trauma patients. These patients require the immediate involvement of a cardiothoracic surgeon.

Renal failure patients may have a uraemia induced pericardial effusion that can compromise the circulation. Ultrasound assisted pericardiocentesis is the management. Pericardiocentesis is only performed by experienced practitioners.

TOXINS

There are many toxins that can cause arrest, including prescribed medications and illicit drug use. Some of these have specific antidotes that will need to be considered for successful resuscitation to occur. For example, tricyclic antidepressant overdose will require sodium bicarbonate therapy. Digoxin toxicity causing cardiac arrest will require digoxin antibodies (Digibind). A toxicologist, clinical pharmacologist or other poisons information service may need to be contacted during the arrest.

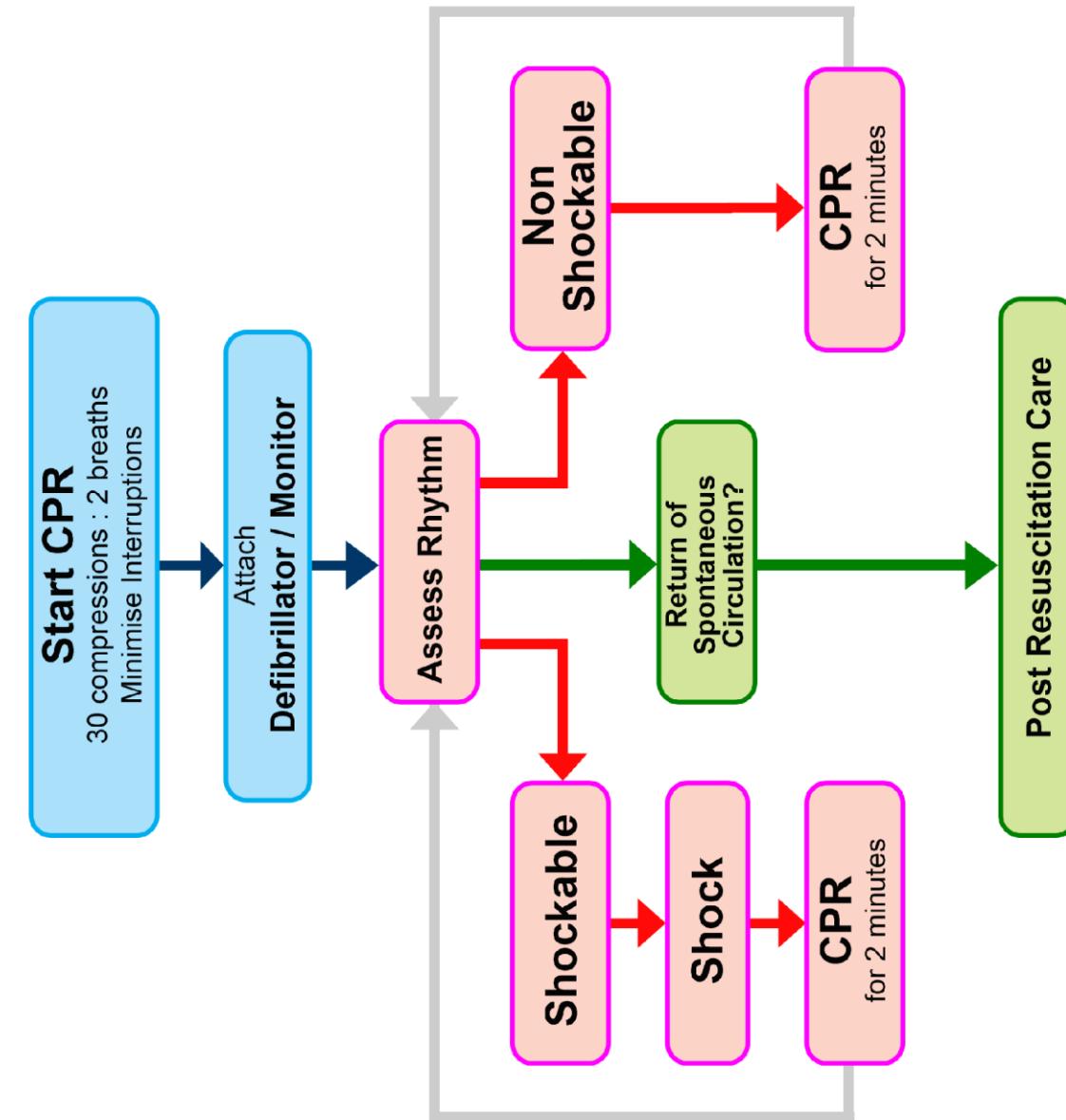
Severe anaphylaxis can cause arrest from airway obstruction or profound hypotension from vasodilation. There may be a widespread erythematous rash to assist in diagnosis, but there may not be any skin changes. Common causes in hospital include IV antibiotics, IV contrast agents, neuromuscular blocking agents and latex contact. It will occur within minutes, rather than hours, of administration. Treatment for cardiac arrest from anaphylaxis is with intravenous adrenaline as per the ALS algorithm. For patients with suspected anaphylaxis NOT in cardiac arrest, the treatment is adrenaline (1:1000) 0.5mg IM (not IV) as per the SVH anaphylaxis guideline (attached to the arrest trolley).

THROMBOEMBOLISM

A large pulmonary embolus (PE) can cause cessation of cardiac output. Routine use of thrombolysis is not recommended but if there is a strong level of suspicion that PE is the cause of the arrest, thrombolysis can be used in an attempt to gain return of circulation. Resuscitation will need to continue for twenty minutes after thrombolytic agent is administered in order for the therapy to have a chance to work.

Acute myocardial ischaemia (AMI) will need to be treated by urgent percutaneous coronary intervention (PCI) or thrombolysis.

Advanced Life Support for Adults



| <u>During CPR</u> | |
|--|--|
| Airway adjuncts (LMA / ETT) | |
| Oxygen | |
| Waveform capnography | |
| IV / IO access | |
| Plan actions before interrupting compressions (e.g. charge manual defibrillator) | |
| <u>Drugs</u> | |
| <u>Shockable</u> | |
| * Adrenaline 1 mg after 2nd shock (then every 2nd loop) | |
| * Amiodarone 300mg after 3 shocks | |
| <u>Non Shockable</u> | |
| * Adrenaline 1 mg immediately (then every 2nd loop) | |
| <u>Consider and Correct</u> | |
| Hypoxia | |
| Hypovolaemia | |
| Hyper / hypokalaemia / metabolic disorders | |
| Hypothermia / hyperthermia | |
| Tension pneumothorax | |
| Tamponade | |
| Toxins | |
| Thrombosis (pulmonary / coronary) | |



January 2016

ALS ALGORITHM

Advanced life support aims to get return of spontaneous circulation via three interrelated objectives:

- 1. Rhythm control**
- 2. Oxygenation of heart and brain**
- 3. Reversing any contributing causes**

Rhythm control is reversion of the patient from ventricular fibrillation or pulseless ventricular tachycardia into a coordinated rhythm. Defibrillation occurs with the utmost priority for shockable rhythms. From then on, the rhythm is analysed every 2 minutes on all patients and a single shock delivered if the rhythm is VF or VT. Amiodarone 300mg IV is administered after the third unsuccessful shock, leading up to the fourth defibrillation attempt.

Patients in a “non shockable” rhythm should have their rhythm and pulse checked every 2 minutes.

Oxygenation of heart and brain is done by deep, fast, uninterrupted chest compressions, ventilation with 100% oxygen and the administration of adrenaline 1mg IV every second cycle. Oxygenation of the heart will make it more responsive to defibrillation and reduce myocardial dysfunction post arrest. Brain oxygenation is important to maximise neurological function post arrest.

Reversing any contributing causes is done in all arrests and again once return of spontaneous circulation has been achieved. These causes are easily remembered by “the four Hs and the four Ts”. Considering each of the reversible causes in every patient can uncover treatable problems that may otherwise have been overlooked.

Patients who arrest in hospital at SVH that are not responsive to the above measures may be considered for extracorporeal membrane oxygenation (ECMO) by the intensivist on call. They will make this decision and contact the relevant practitioners.

THE LUCAS DEVICE

The LUCAS 2 is an external compression device that is used to replace manual compressions. Studies have not shown the LUCAS compressions to be superior to manual compressions but there are the following benefits:

1. Patient transport
 - Patients can be transferred to the angiography suite or intensive care while still undergoing chest compressions
2. Patient access
 - It is easier to access the patient for procedures such as ECMO
3. Continuous compressions
 - LUCAS compressions actively pull up the chest wall, facilitating ventilation and allowing for continuous chest compressions

There is a LUCAS 2 in SVH Emergency Department and the Intensive Care Unit. The arrest team will not arrive with the LUCAS but simply fetch it if it is indicated. The Emergency Department prepares the LUCAS for any incoming arrest. (See over)



ST VINCENT'S HOSPITAL EMERGENCY DEPARTMENT
LUCAS 2 INSTRUCTION GUIDELINES

Batphone of cardiac arrest received

- 1 person allocated to Lucas 2
- Back board placed on trauma trolley
- LUCAS turned ON

- Patient arrives
- Continue manual compressions
- Transfer patient onto LUCAS backboard



- Attach LUCAS to backboard, click in and **PRESS 1**
Position cup over centre of chest and push it down so it touches the patient's chest (*manual compressions have to stop*)
- **PRESS 2** (*locks cup in place*)
- **PRESS 3** (*top play button for all patients*)
- **Ventilation delivered during chest recoil at 6-10/min**

- **PRESS 2** (*pause button*) to assess rhythm +/- pulse
- **PRESS 3** (*top play button*) to restart compressions

SHOCKABLE

- Charge defibrillator
- Deliver shock
(during compressions)

NON SHOCKABLE

- Compressions continue for inadequate cardiac output
- Continue ALS algorithm

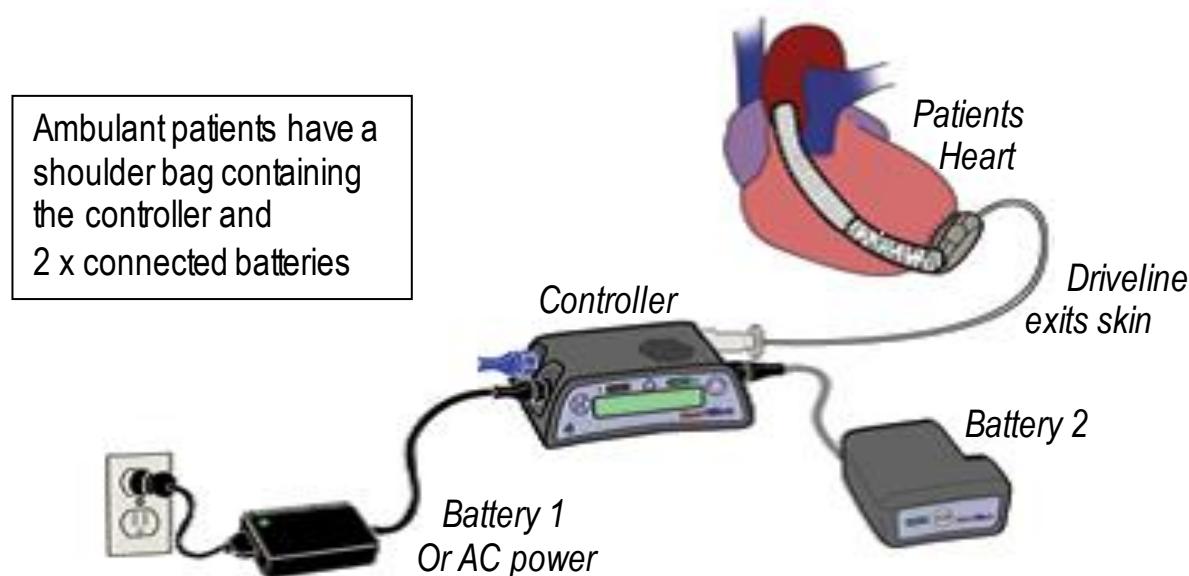
*ONLY STAFF WHO HAVE ATTENDED THE PRACTICAL WORKSHOP ARE ALLOWED TO MANAGE THE LUCAS

*REFER TO INSTRUCTION MANUAL (KEPT IN THE LUCAS 2 BAG) FOR MORE DETAILED INFORMATION

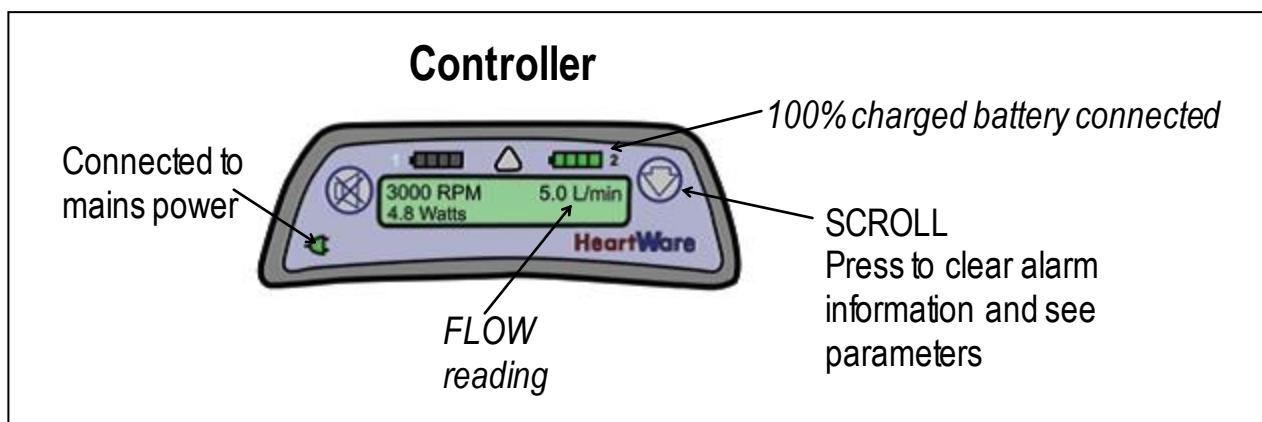
VAD patients (Ventricular Assist Device)

St Vincent's hospital inserts and looks after all the patients in NSW with a ventricular assist device (VAD). The devices are commonly left ventricular (LVAD) but may also be right (RVAD) or both ventricles (BiVAD).

These patients are cared for in specialised areas with specifically trained and experienced staff. The patient and their carer are well educated in the management of their device and will contact the VAD CNC directly if there is a problem.



Patients away from home must always have with them;
2 x Controllers (one in use and one spare)
4 x fully charged batteries (two connected and two spare)
AC power adapter



Important points to note:

- Patients with VAD have continuous blood flow and so do not have a palpable pulse. Mean arterial pressure is measured using Doppler.
- Patients may be in ventricular fibrillation and still be conscious as the VAD provides adequate circulation. In these cases, defibrillation should be performed electively in a controlled environment. Defibrillation is done without disconnecting any part of the VAD.
- Low VAD flows may not be the reason that a VAD patient is unconscious. If the controller screen shows that there is flow (even if it is as low as 2L/min) then circulation is present. Pump activity is audible on auscultation of the heart.
- VAD is a valveless connection from LV to aorta. Chest compressions will result in retrograde flow through the VAD from the aorta back to the left ventricle and so diminishing any benefit to the circulation.
- The pump location and position of the outflow graft on the aorta mean there is a theoretical risk of trauma from chest compressions. Chest compressions should only be performed under the Transplant Team instructions.

Should you witness or be called to the collapse of a patient with a VAD:

1. Check for response.
2. Call a CODE BLUE and Transplant Physician and Cardiothoracic Surgeon
3. Airway – open and clear
4. Breathing – assist ventilation, administer oxygen
5. Circulation – check the VAD (see diagrams)
 - a. Ensure driveline is connected to the controller
 - b. Controller is connected to power source (charged battery or mains)
 - c. Note any alarm information on control screen
 - d. Press scroll button to clear any alarm information and read parameters
6. If possible, move to resuscitation area, IV access, Doppler MAP, BSL, etc
7. Await Transplant Team instruction

ROLES

Knowledge of the ALS algorithm is only part of a well-run arrest. Carrying out the various components of ALS requires a team. There needs to be clear role allocation for people to function as a team, rather than just as a group of people.

The arrest page at SVH goes out instantly to two intensive care nurses, two intensive care registrars and one anaesthetic registrar. The manual defibrillator is brought from intensive care and within its carry bag are the intraosseous drill and additional drugs – eg. amiodarone, propofol and suxamethonium. The arrest team will bring the cardiac arrest pack and oxygen and suction if the arrest is in a non-clinical area like the foyer of the hospital.

The following is a list of suggested roles during a cardiac arrest. Role delegation does depend on staff numbers and level of experience. The team usually increases in size and experience as members of the arrest team arrive. Role allocation therefore often needs to be redistributed during the arrest.

| |
|--|
| TEAM LEADER |
| DEFIBRILLATOR +/- TIMEKEEPER |
| CHEST COMPRESSORS (2 PEOPLE) |
| AIRWAY (2 PEOPLE) |
| IV ACCESS/ BLOOD TESTS/ EXAMINATION |
| DRUGS |
| SCRIBE |
| RUNNER / MEDICAL NOTES RV / PHONE CALLS |

Specialised areas like the emergency department, ICU and theatres have predetermined roles suited to that environment. If you would like more information on this, consult senior nursing or medical staff in these areas.

TEAM LEADER

A team always needs a leader. An arrest situation benefits greatly from one person taking up the leadership role right from the moment the arrest is recognised. The leader can delegate people to call for help, start chest compressions, attach the defibrillator, etc. The initial team leader can be you.

At SVH, the intensive care registrar is the default team leader for ward code blue calls. They will not be there immediately, so someone will need to take up this role initially. Everyone needs to clearly know who the team leader is. Stating out loud “I’ll be the team leader” is an effective way of achieving this.

Hand over to the team leader needs to be clear and concise. After introducing yourself, state the patient's name, age, diagnosis, followed by a brief summary of what happened and where you are up to in the ALS algorithm.

The team leader's first priority is to check that effective chest compressions and defibrillation are occurring. The team leader can then confirm or allocate the remaining roles. The team leader then guides the team through the algorithm and reversible causes.

It is usually recommended that the team leader stand at the foot of the bed in order to see the patient and all the team members. The team leader should not be involved in carrying out clinical tasks as this takes their focus off the whole picture.

AIRWAY

Airway and ventilation management have been discussed in previous sections. If there are enough people present, having two people at the airway is ideal. This allows one person to hold the mask on with both hands whilst the other person delivers the breaths. The anaesthetic registrar usually takes up an airway role when they arrive as part of the arrest team. An ICU nurse or ward nurse can be the airway assistant. They can assess and manage the airway and breathing.

CHEST COMPRESSORS

Performing effective chest compressions is tiring. Have at least two people delegated to this task so that they can swap at 2-minute intervals.

DEFIBRILLATOR

The defibrillator is responsible for ensuring only the patient gets a shock from defibrillation. "Stand clear!" needs to be audible to everyone, but a visual sweep of the bed is necessary for those not paying attention. As rhythm analysis +/- defibrillation occurs every two minutes and a clock is on each machine, the defibrillator can also be the timekeeper.

DRUGS

This role involves preparation and administration of drugs and fluids.

IV ACCESS/ BLOODS/ EXAMINATION

This role involves establishing adequate IV or IO access and taking blood for gas analysis (venous or arterial). Physical examination of the patient to look for reversible causes may be done by this person or delegated as required.

RUNNER

This person brings the patient's notes to the bedside, double-checking that it is indeed the correct patient. They can provide relevant information from the notes to the team. The runner may need to take phone calls and look up results.

SCRIBE

This is arguably the most difficult role of all. It relies heavily on good communication of the team in order to know what is going on. This role is essential for documentation of the arrest.

MRI SAFETY

The magnet in the MRI machine is always on. It is a very powerful magnetic field such that metallic objects in the room can cause serious injuries and damage the MR system. Only authorised staff enters the MRI room. MRI staff will bring the patient out of the MRI room if an arrest call is being made.

COMMUNICATION

Communicating effectively within a team during an arrest requires specific strategies. Information and voices need to be kept to a minimum so that everyone can hear and comprehend what is being said. Communication during an arrest needs to be simple, clear and concise.

Excessive noise levels are usually the result of many conversations going on simultaneously and everyone speaking louder and louder in order to be heard. This increases the stress of the situation and makes team function more difficult than it needs to be.

Instructions given “to the air” tend to result in tasks not carried out by anyone, or many people clambering to carry out the same job. It is more effective if instructions are directed to a specific person, preferably by name.

The role of team leader is central to communication within the team. Team communication should all go through the team leader. Team members deliver information to the team leader and the team leader coordinates activities by giving instructions to the team members. The team leader summarises the situation and states the plan so that everyone is able to know what is going on.

Delivery of an instruction needs to be delivered to a specific person. This is much easier to do if you know the other team members’ names and level of experience. Introduce yourself by name and role to the team leader when joining the team to facilitate smoother delegation of duties.

“Hearing back” is an expression referring to the practice of restating an instruction received. This is an opportunity to realise and correct mistakes and reinforces to the whole team what is being said, enhancing team situation awareness. Closed-loop communication is not only hearing back but also affirming that the action has been commenced or completed.

CLOSED – LOOP COMMUNICATION

TEAM LEADER: “Drugs person,
 Please give adrenaline 1mg IV”

DRUGS PERSON: “You want adrenaline 1mg IV”

Drugs person administers the adrenaline to the patient

DRUGS PERSON: “Adrenaline 1mg IV given”

*The noise level is so low that the scribe and the rest of the team
are also able to hear that adrenaline has just been given.*

This is not the way we would normally communicate and it doesn't come naturally to most of us. It is, however, an effective way of communicating well and reducing errors in a stressful environment.

Language needs to be clear, precise and unambiguous. Use of generic medication names is recommended and should always include the dose and route of administration. Care needs to be taken that numbers are not misheard. For example, fifteen can be misheard as fifty, so may need to be clarified by stating “fifteen, that is, one-five”. Caution is required when using prefixes such as hyper- and hypo- and can be more clearly expressed by simply saying high or low.

POST RESUSCITATION CARE

Return of spontaneous circulation marks the beginning of post resuscitation care. Future heart and neurological function after an arrest depends on the quality of post resuscitation care. This needs to occur in a critical care area, which from the general ward means prompt transfer of the patient to the coronary or intensive care unit. It is beyond the scope of this booklet to go into detail, but the ALS team should be aware of the following principles.

- **Airway management**

The patient who remains unconscious after an arrest will require airway support and protection, ultimately by intubation. Whether this occurs on the ward or is in fact safer to be performed in ICU is a decision to be made by the experienced people present. The awake patient should receive supplemental oxygen titrated to O₂ saturation 94-98%.

- **Good oxygenation and perfusion need to be maintained**

Maintaining good perfusion requires an adequate circulating blood volume and blood pressure. These patients may require ionotrope (e.g. adrenaline) infusion or even an intra aortic balloon pump. The blood pressure should not be allowed to fall while awaiting transfer to a critical care area. In this situation, ionotrope infusion or small incremental dosing (eg. adrenaline 50 – 100 mcg IV) should commence prior to transfer.

- **Rhythm control**

Good perfusion also relies on a good cardiac rhythm. Second or third degree heart block may require external pacing as a temporising measure to internal pacing wire insertion. Antiarrhythmic medication and correcting electrolyte abnormalities will also assist with rhythm control.

- **Cause of the arrest**

Consider the cause of the arrest. The four Hs and four Ts should again be considered. A 12 lead ECG may show evidence of ischaemia that warrants urgent percutaneous coronary intervention (PCI). A drug overdose may require specific antidotes, decontamination or dialysis.

- **Targeted temperature management**
Patients with return of spontaneous circulation but ongoing coma may be cooled to 36°C for at least 24 hours to maximise their neurological recovery.
- **Complications of the resuscitation**
Cardiac compressions can result in rib fractures and patients may require analgesia post arrest. Rib fracture also puts patients at high risk of pneumothorax, particularly if they are receiving positive pressure ventilation.
- **Glucose control**
Hypoglycaemia is detrimental to good recovery and hyperglycaemia may have negative effects also. Blood glucose level should be maintained between 5 and 10 mmol/L.
- **Communication**
Communication in the post recovery phase usually involves a lot of phone calls. The patient should be transferred to the appropriate critical care unit as soon as possible. The patient's team need to be notified and involved. Cardiology consultation is usually required. The patient's relatives need to be informed of the events.
- **Prognosis**
It is impossible to predict accurately the degree of neurological recovery during or immediately after cardiac arrest. Relying on the neurological examination during or immediately after cardiac arrest to predict outcome is not recommended and should not be used.

TALKING TO THE RELATIVES

In recent years, we are recognising the benefit of allowing the next-of-kin to be present during an arrest if they so wish. This is on the proviso that their presence does not adversely affect or interfere with the clinical management of the patient. Just as importantly, the relative must have a delegated chaperone to explain what is happening. The chaperone must be an ALS experienced registered nurse or medical officer dedicated to the task.

The most compelling reason for having the next of kin present is the humane aspect of allowing them to be with their loved one if they wish during what is often the last moments before the patient's death. It is also often much easier to explain that "we did all we could" when the relative has witnessed the team doing all they can for the patient.

For the relative, these moments may remain in the forefront of their memory for years to come. How we look after them can have a tremendous impact on their future quality of life.

DEBRIEFING

As health care workers, we need to look out for and support each other. Everyone wants to do the best for patients and most staff members are upset if a patient dies unexpectedly, particularly if they have been involved in that patient's care.

Clinical debriefing may be organised if there were issues of conflict or difficult clinical decisions during the arrest. This can help educate staff and instil confidence for dealing with future arrest. Reflecting on performance should only be done in an emotionally safe environment and in a constructive manner.

Emotional debriefing does not need to be a formal process. Informal discussions with workmates can be invaluable and sufficient. Take the time to reflect on the effect a situation may have had on you and seek support from colleagues or mentors if you think you need it. Be sensitive to those around you and offer your support to them.

NOT FOR RESUSCITATION & END OF LIFE DECISIONS

When to start

Ideally, the patient and relatives have made end of life decisions, with the assistance of the admitting team, prior to the arrest. This should be documented clearly and is highlighted by an NFR form in the patient's notes.

In the absence of such documentation, resuscitation needs to occur until a senior medical officer can clarify the situation with the patient's relatives and/or admitting consultant. These difficult situations highlight the benefit of advanced directives.

When to stop

The decision to cease attempting resuscitation when it is deemed futile is a medical decision and is made on a case-by-case basis by the most senior medical officer present, with team endorsement, and using telephone consultation to someone more senior if necessary. The onus of this decision is not to be placed on relatives.

The patient's relatives need to be informed of the death as soon as possible. This should not occur over the telephone. A senior nursing staff member, medical officer and social worker should do this. Pastoral care can be offered to the family. Referral of the death to the state coroner may be required.

REFERENCES

Australian Resuscitation Council
Guidelines 2016
www.resus.org.au

International Liaison Committee for Resuscitation (ILCOR)
Guidelines 2015
www.ilcor.org

APPENDIX

CONTENTS OF THE ARREST TROLLEY

Ensure you know the location of the arrest trolley in your area of work. Familiarise yourself with its contents. The trolleys are checked once a day with missing items replaced immediately. No extra items are to be added to the trolley.

There are standard arrest trolley contents for general wards, but this is modified in different areas e.g. ED, ICU, CCU, etc. There is a defibrillator on most arrest trolleys. In non-critical care areas, this will be an automatic external defibrillator (AED). In critical care areas there will be a manual defibrillator.

General Ward Arrest Trolley Contents

Drawer 1 AIRWAY

- 2 x Face masks, small adult size 4 and adult size 5
- 2 x One-way valves
- 2 x Guedel airways; 1 x medium 9cm and 1 x large 10cm
- 1 x Yankauer sucker
- 2 x Laryngeal Mask Airways (LMA); 1 x #3 Classic LMA and 1 x #4 Classic LMA
- Disposable Material Bundle Containing:
 - 2 Laryngoscope handles with long disposable blades
 - 3 Uncut Endotracheal Tubes (ETT) Sizes 6, 7 & 8
 - Each fitted with 15mm plastic connector
 - 1 Magill forceps, disposable
 - 1 Intubating stylet, disposable
 - 1 10ml syringe
 - 2 Lubricating jelly sachets
 - 1 length of white cotton tape to secure ETT
- 1 x Blue Bougie (disposable tracheal tube guide)
- 2 x Y suction catheters 12FG
- 1 x Universal scissors, safety tip
- Suction tubing 3 metre

Drawer 2 DRUGS

- 1 Glucose 50% / 50mL bottle
- 1 Sodium Bicarbonate 8.4% / 100mL bottle
- 1 Glucose 5% 100mL bag
- 1 Atropine 600mcg / 1mL amp
- 1 Calcium Chloride 10% / 10ml vial
- 8 Adrenaline 1:10,000 / 10ml amp
- 5 Adrenaline 1mg / 1ml amp
- 2 Preloaded KCL10mmols/ 100mL 0.29% Saline bag
- 1 Magnesium sulphate 20mmols / 10mL vial
- 2 Naloxone 400mcg / 1mL amp
- 10 Sodium Chloride 10mL amp
- Syringes: blood gas x 2; 2mL x 5; 5mL x 5; 10mL x 5; 20mL x 5
- 18 g Drawing up needle x 10
- 21g needles x 5
- Vial access cannulas x 5
- Chlorhexidine alcohol wipes x 10

NB. Amiodarone and intubating drugs will come with the Arrest Team

Drawer 3 CIRCULATION

- Cannula
 - 1 x 14 gauge (safety)
 - 2 x 18 gauge (safety)
 - 2 x 20 gauge (safety)
- 3 Smart Site (cannula caps)
- 1 Micropore Tape 2.5cm
- 2 Cannulation packs
- 4 pkts gauze swabs
- 1 Alaris Intravenous Set
- 1 Blood Pump Giving Set
- Tourniquet (single use)
- 2 Kidney Dishes

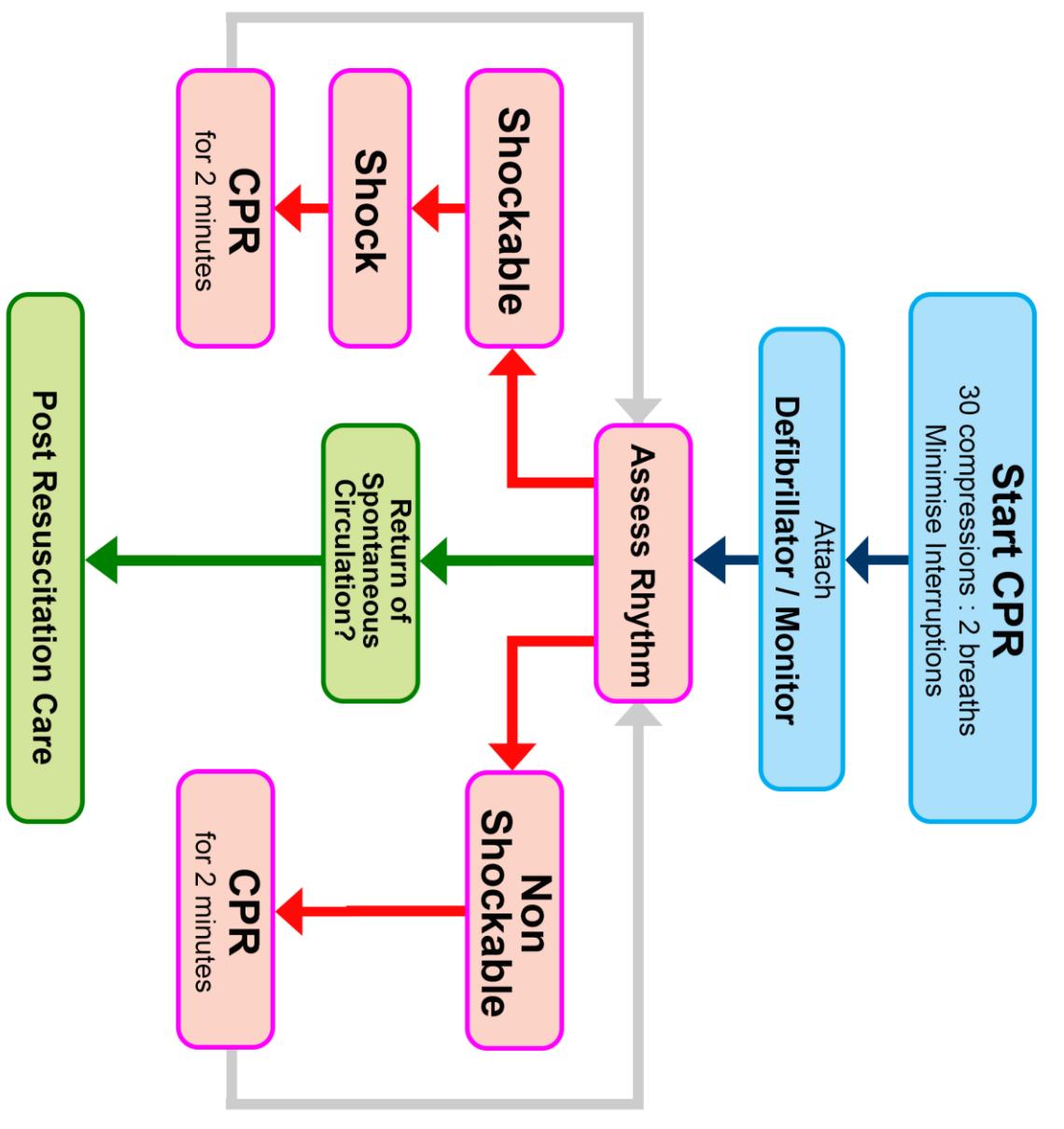
Drawer 4 MISCELLANEOUS

- 1 Sodium Chloride 0.9% 500mL bag
- 1 Oxygen Mask with oxygen tubing
- 1 Box Face Shields
- 1 Open tailed resuscitation circuit (disposable)
- 1 Manual Resuscitator (disposable)
- *spare material bundle containing:*
 - 2 x Laryngoscope blades (disposable)
 - 3 x Uncut ETT Sizes 6,7 and 8
 - Intubating stylet
 - Magill forceps
 - 10ml syringe, 2 lubricant sachets
 - 1 length of white cotton tape to secure ETT

Top, Sides and Back of the Trolley

- AED - says **'OK'**, (in handle)
- Defibrillator pads are attached to AED and spare set in lid.
- O₂ cylinder with gauge, flow meter, twin-o-vac, suction tubing
- Resuscitation chart attached to clipboard
- Sharps container with bracket
- Arrest trolley contents list
- BLS flow chart
- ANZCOR ALS flow chart.
- SVH Anaphylaxis flow chart

Advanced Life Support for Adults



| | |
|--------------------------------|--|
| Post Resuscitation Care | Re-evaluate ABCDE |
| | 12 lead ECG |
| | Treat precipitating causes |
| | Aim for: SpO ₂ 94-98%, normocapnia and normoglycaemia |
| | Targeted temperature management |



January 2016



NEW ZEALAND
Resuscitation Council
WHAKAHAUORA AOTEAROA