1. The guideline process

The process used to produce the Resuscitation Council UK Guidelines 2015 has been accredited by the National Institute for Health and Care Excellence. The guidelines process includes:

- Systematic reviews with grading of the quality of evidence and strength of recommendations. This led to the 2015 International Liaison Committee on Resuscitation (ILCOR) Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science with Treatment Recommendations. 1,2
- The involvement of stakeholders from around the world including members of the public and cardiac arrest survivors.
- Details of the guidelines development process can be found in the Resuscitation Council UK Guidelines Development Process Manual.
- These Resuscitation Council UK Guidelines have been peer reviewed by the Executive Committee of Resuscitation Council UK, which comprises 25 individuals and includes lay representation and representation of the key stakeholder groups.

2. Summary of changes since 2010 Guidelines

The 2015 Guidelines do not include any major changes to core in-hospital resuscitation interventions since the previous guidelines published in 2010.
The key changes since 2010 are:

- Continuing emphasis on the use of rapid response systems for care of the deteriorating patient and prevention of in-hospital cardiac arrest.
- Continued emphasis on providing minimally interrupted high-quality chest compressions throughout CPR: chest compressions are paused briefly only to enable specific interventions. This includes minimising interruptions in chest compressions to attempt defibrillation.

3. Introduction

These Guidelines are aimed primarily at healthcare professionals who are first to respond to an in-hospital cardiac arrest and may also be applicable to healthcare professionals working in other clinical settings. Resuscitation Council UK has produced Quality Standards for cardiopulmonary resuscitation and training to support the implementation of this guideline.

The use of rapid response systems for care of the deteriorating patient and prevention of in-hospital cardiac arrest is specifically addressed in Prevention of cardiac arrest and decisions about CPR. After in-hospital cardiac arrest the division between basic life support (BLS) and advanced life support (ALS) is arbitrary; in practice, the resuscitation process is a continuum. For all in-hospital cardiac arrests, ensure that:

- cardiorespiratory arrest is recognised immediately
- help is summoned using a standard telephone number (e.g. 2222)\(^3\)
- CPR is started immediately and, if indicated, defibrillation is attempted as soon as possible (within 3 min)

All in-hospital cardiac arrests should be reviewed as part of an audit and quality improvement process. Details should be recorded after each event. The National Cardiac Arrest Audit (NCAA) enables hospitals to collect standardised data and monitor changes in cardiac arrest activity.

4. Sequence for a collapsed patient in hospital

An algorithm for the initial management of in-hospital cardiac arrest is shown in
1. Ensure personal safety
• There are very few reports of harm to rescuers during resuscitation.\textsuperscript{4}
• Your personal safety and that of resuscitation team members is the first priority during any resuscitation attempt.
• Check that the patient’s surroundings are safe.
• Put on gloves as soon as possible. Other personal protective equipment (PPE) (eye protection, face masks, aprons, gowns) may be necessary especially when the patient has a serious infection such as tuberculosis. Follow local infection control measures to minimise risks.
• Be careful with sharps; a sharps box must be available. Use safe handling techniques for moving victims during resuscitation. Resuscitation Council UK has produced Guidance for safer handling during cardiopulmonary resuscitation in healthcare settings.

2. Check the patient for a response

• If you see a patient collapse or find a patient apparently unconscious assess if they are responsive (shake and shout). Gently shake their shoulders and ask loudly: “Are you all right?”
• If other members of staff are nearby it will be possible to undertake several actions simultaneously.

3A. If the patient responds

• Urgent medical assessment is required. Call for help according to local protocols. This may include calling a resuscitation team (e.g. medical emergency team (MET)).
• While waiting for the team, assess the patient using the ABCDE (Airway, Breathing, Circulation, Disability, Exposure) approach.
• Give the patient oxygen. Use a pulse oximeter to guide oxygen therapy.\textsuperscript{5}
• Attach monitoring: a minimum of pulse oximetry, ECG and blood pressure.
• Record vital signs observations and calculate the early warning score.
• Obtain venous access and take blood samples for investigation.
• Prepare for handover using SBAR (Situation, Background, Assessment, Recommendation) or RSVP (Reason, Story, Vital signs, Plan).\textsuperscript{6,7}

3B. If the patient does not respond
• Shout for help (if not done already).
• Turn the patient on to their back.
• Open the airway using head tilt and chin lift.
• If there is a risk of cervical spine injury, establish a clear upper airway by using jaw thrust or chin lift in combination with manual in-line stabilisation (MILS) of the head and neck by an assistant (if enough people are available). If life-threatening airway obstruction persists despite effective application of jaw thrust or chin lift, add head tilt a small amount at a time until the airway is open; establishing a patent airway, oxygenation and ventilation takes priority over concerns about a potential cervical spine injury.
• Keeping the airway open, look, listen, and feel to determine if the victim is breathing normally. This is a rapid check and should take less than 10 seconds:
  ◦ Look for chest movement (breathing or coughing)
  ◦ Look for any other movement or signs of life
  ◦ Listen at the victim’s mouth for breath sounds
  ◦ Feel for air on your cheek
• If trained and experienced in the assessment of sick patients, check for breathing and assess the carotid pulse at the same time. The assessment should take less than 10 seconds whether you do a pulse check or not.
• Agonal breathing (occasional, irregular gasps) is common in the early stages of cardiac arrest and is a sign of cardiac arrest and should not be mistaken for a sign of life. Agonal breathing and limb movement can also occur during chest compressions as cerebral perfusion improves, but is not indicative of a return of spontaneous circulation (ROSC).
• Changes in skin colour (e.g. pallor, cyanosis) in isolation are not diagnostic of cardiac arrest.  
• If the patient is already attached to monitoring in a critical care area this will add to rather than replace the assessment for signs of life.

4A. If there are signs of life or a pulse

• Urgent medical assessment is required. Depending on the local protocols, this may take the form of a resuscitation team.
• While awaiting the team, assess and treat the patient using the ABCDE approach.
• Follow the steps in 3A whilst waiting for the team.
• The patient is at high risk of further deterioration and cardiac arrest and needs continued observation until help arrives.

4B. If there are no signs of life and no pulse

• Start CPR and get a colleague to call the resuscitation team and collect the resuscitation equipment and a defibrillator.
• If alone, leave the patient to get help and equipment.
• Chest compressions in a patient whose heart is still beating are unlikely to cause harm. However, delays in diagnosing cardiac arrest and starting CPR will adversely affect chances of survival and must be avoided, so if there is any doubt proceed as if there are no signs of life and no pulse.
• Give 30 chest compressions followed by 2 ventilations.
• The correct hand position for chest compression is the middle of the lower half of the sternum.
• This hand position can be found quickly if you have been taught to ‘place the heel of one hand in the centre of the chest with the other hand on top’ and your teaching included a demonstration of placing hands in the middle of the lower half of the sternum.
• Ensure high quality chest compressions:
  ◦ Depth of 5–6 cm
  ◦ Rate of 100–120 compressions min⁻¹
  ◦ Allow the chest to recoil completely after each compression
  ◦ Take approximately the same amount of time for compression and relaxation
  ◦ Minimise any interruptions to chest compression (hands-off time)
• If available, use a prompt and/or feedback device to help ensure high quality chest compressions. The use of these devices should be part of a hospital-wide quality improvement program that includes formal debriefing.
• Do not rely on palpating carotid or femoral pulses to assess the effectiveness of chest compressions.
• Resume compressions without any delay; place your hands back on the centre of the patient's chest.
• If there are enough team members, the person doing chest compressions should change about every 2 min or sooner if they are unable to maintain high quality chest compressions. This change should be done with minimal interruption to compressions. This should be done during planned pauses in chest compression such as during rhythm assessment.
• Use whatever equipment is available immediately for airway and ventilation
(e.g. a self-inflating bag-mask, or a supraglottic airway device and bag according to local policy).

- Use an inspiratory time of about 1 second and give enough volume to produce a visible rise of the chest wall. Avoid rapid or forceful breaths.
- Add supplemental oxygen as soon as possible.
- There are usually good clinical reasons to avoid mouth-to-mouth ventilation in clinical settings, and it is therefore not commonly used, but there will be situations where giving mouth-to-mouth breaths could be life-saving (e.g. in non-clinical settings). If there are clinical reasons to avoid mouth-to-mouth contact, or you are unable to do this, do chest compressions until help or airway equipment arrives. A pocket mask or bag-mask should be immediately available in all clinical areas.
- Tracheal intubation should be attempted only by those who are trained, competent and experienced in this skill, and can insert the tracheal tube with minimal interruption (less than 5 seconds) to chest compressions. Waveform capnography must be used routinely for confirming that a tracheal tube is in the patient’s airway and subsequent monitoring during CPR. Waveform capnography can also be used to monitor the quality of CPR, as an indicator of a ROSC and to help with determining prognosis during CPR.
- Once the patient’s trachea has been intubated, continue chest compressions uninterrupted (except for defibrillation or rhythm checks when indicated), at a rate of 100–120 min\(^{-1}\), and ventilate the lungs at approximately 10 breaths min\(^{-1}\) (i.e. do not stop chest compressions for ventilation). If a supraglottic airway (e.g. LMA) device has been inserted it may also be possible to ventilate the patient without stopping chest compressions.
- As soon as a defibrillator arrives, apply the self-adhesive pads to the patient’s chest whilst chest compressions are ongoing. The use of adhesive electrode pads will enable rapid assessment of heart rhythm compared with the use of ECG electrodes.\(^4\)
- Once the pads are applied, pause briefly for a rapid rhythm check – aim for a pause in chest compressions of less than 5 seconds.
- If the rhythm is ventricular fibrillation/pulseless ventricular tachycardia (VF/pVT), restart chest compressions. All other team members must now be informed to stand clear of the patient whilst the defibrillator is charged and a safety check performed. Once the defibrillator is charged and the safety check completed, stop chest compressions, deliver the shock and restart chest compressions immediately.
- Do not delay restarting chest compressions to check the cardiac rhythm.
• Using a manual defibrillator, it is possible to reduce the pause between stopping and restarting of chest compressions to less than 5 seconds.
• If staff cannot use a manual defibrillator, use an automated external defibrillator (AED). Switch on the AED and follow the audio-visual prompts.
• Rescuers must not compromise on safety. All actions should be planned by the team before pausing chest compressions. If there are delays caused by difficulties in rhythm analysis or if individuals are still in contact with the patient, chest compressions are restarted whilst a decision is made what to do when compressions are next paused.
• Continue resuscitation until the resuscitation team arrives or the patient shows signs of life. Follow the Advanced life support algorithm.
• Once resuscitation is underway, and if there are sufficient staff present, prepare intravenous cannulae and drugs likely to be used by the resuscitation team (e.g. adrenaline).
• Use a watch or clock for timing between rhythm checks. Any interruption to CPR should be planned. Assess the cardiac rhythm about every 2 minutes.
• Identify one person to be responsible for handover to the resuscitation team leader. Use a structured communication tool for handover (e.g. SBAR, RSVP).
• Locate the patient’s records and ensure that they are available immediately when the resuscitation team arrives.

4C. If the patient is not breathing and has a pulse (respiratory arrest)

• Ventilate the patient’s lungs (as described above) and check for a pulse every 10 breaths (about every minute).
• This diagnosis can be made only if you are confident in assessing breathing and pulse or the patient has other signs of life (e.g. warm and well-perfused, normal capillary refill).
• If there are any doubts about the presence of a pulse, start chest compressions and continue ventilations until more experienced help arrives. All patients in respiratory arrest will develop cardiac arrest if the respiratory arrest is not treated rapidly and effectively.

5. If the patient has a monitored and witnessed cardiac arrest
If a patient has a monitored and witnessed cardiac arrest in the catheter laboratory, coronary care unit, a critical care area, or whilst monitored after cardiac surgery, and a manual defibrillator is rapidly available:

- Confirm cardiac arrest and shout for help.
- If the initial rhythm is VF/pVT, give up to three quick successive (stacked) shocks.
- Rapidly check for a rhythm change and, if appropriate check for a pulse and other signs of ROSC after each defibrillation attempt.
- Start chest compressions and continue CPR for 2 min if the third shock is unsuccessful. These initial three stacked shocks are considered as giving the first shock in the ALS algorithm.
- This three-shock strategy may also be considered for an initial, witnessed VF/pVT cardiac arrest if the patient is already connected to a manual defibrillator – these circumstances are rare.
- A precordial thump works only rarely. Delivery of a precordial thump must not delay calling for help or accessing a defibrillator. Consider a precordial thump only when it can be used without delay whilst awaiting the arrival of a defibrillator in a monitored VF/pVT arrest. Using the ulnar edge of a tightly clenched fist, deliver a sharp impact to the lower half of the sternum from a height of about 20 cm, then retract the fist immediately to create an impulse-like stimulus.

5. Background notes

Hospital and staff factors

The exact sequence of actions after in-hospital cardiac arrest depends on several factors including:

- location (clinical or non-clinical area; monitored or unmonitored patients)
- skills of staff who respond
- number of responders
- equipment available
- hospital system for response to cardiac arrest and medical emergencies (e.g. MET, cardiac arrest team).
Location

Monitored cardiac arrests are usually diagnosed rapidly. Ward patients may have had a period of deterioration and an unwitnessed arrest. Ideally, all patients who are at high risk of cardiac arrest should be cared for in a monitored area where facilities for immediate resuscitation are available. Patients, visitors, or staff may also have a cardiac arrest in non-clinical areas (e.g. car parks, corridors).

Delay in attempting defibrillation can occur when patients sustain cardiac arrest in unmonitored hospital beds and in outpatient departments. In these areas several minutes may elapse before a resuscitation team arrives with a defibrillator and delivers a shock. Automated external defibrillation should be considered to facilitate early defibrillation (aiming for shock delivery within 3 min of collapse) in areas where staff have no rhythm recognition skills or use defibrillators infrequently. However, an automated external defibrillator (AED) should not be used in preference to a manual defibrillator when staff are present who have rhythm recognition and manual defibrillation skills.

Skills of staff who respond

All healthcare professionals should be able to recognise cardiac arrest, call for help, and start resuscitation. Staff should do what they have been trained to do. For example, staff in critical care and emergency medicine may have more advanced resuscitation skills than staff who are not involved regularly in resuscitation in their normal clinical role. Hospital staff who attend a cardiac arrest may have different competencies in managing the airway, breathing, and circulation. Rescuers should use those resuscitation skills in which they have been trained.

Resuscitation Council UK’s Immediate Life Support (ILS) course is aimed at the majority of healthcare professionals who attend cardiac arrests rarely but have the potential to be first responders or resuscitation team members. Resuscitation Council UK’s Advanced Life Support (ALS) course is aimed at doctors and senior nurses working in acute areas of the hospital and those who may be resuscitation team leaders and members. The course is also suitable for senior paramedics and some hospital technicians.

During training and clinical practice there should be a greater emphasis on non-technical skills (NTS). These consist of situational awareness, decision making,
team working, team leadership, task management and communication. Tools such as SBAR or RSVP should be used to ensure rapid effective communication and handovers.

Number of responders

The single responder must ensure that help is on its way. If other staff are nearby, several actions can be undertaken simultaneously. Numbers of hospital staff tend to be fewer during the night and at weekends. This may influence patient monitoring, recognition, treatment and outcomes. Data from the US shows that survival rates from in-hospital cardiac arrest are lower during nights and weekends.\textsuperscript{24} Several studies show that increased nurse staffing is associated with lower rates of failure-to-rescue, and reductions in incidence of cardiac arrest, pneumonia, shock and death.\textsuperscript{16,25}

Equipment available

The equipment used for CPR (including defibrillators) and the layout of equipment and drugs should be standardised throughout the hospital. A review by Resuscitation Council UK of serious patient safety incidents associated with CPR and patient deterioration reported to the National Patient Safety Agency showed that equipment problems are a common contributing cause. All resuscitation equipment must be checked regularly to ensure it is ready for use. Specially designed trolleys or sealed tray systems improve speed of access to equipment and reduce adverse incidents.\textsuperscript{26,27}

Hospitals and teams must have monitoring and equipment for transferring patients after they have been resuscitated. This includes portable monitors with a minimum capability of pulse oximetry, ECG, and non-invasive blood pressure measurement. In addition waveform capnography must be used for all patients after tracheal intubation. For further information, refer to the Intensive Care Society’s \textit{Guidelines for the Transport of the Critically ill Adult}.

Resuscitation team

The resuscitation team may take the form of a traditional cardiac arrest team, which is called only when cardiac arrest is recognised. Alternatively, hospitals may have strategies to recognise patients at risk of cardiac arrest and summon a team (e.g. MET) before cardiac arrest occurs. The term ‘resuscitation team’ reflects the range of response teams. In-hospital cardiac arrests are rarely sudden or unexpected. A strategy of recognising patients at risk of cardiac arrest
may enable some of these arrests to be prevented, or may prevent futile resuscitation attempts in those patients who are unlikely to benefit from CPR (See Prevention of in-hospital cardiac arrest and decisions about CPR).

Surveys show that resuscitation teams rarely have formal briefings and/or debriefings. Resuscitation team members should meet for introductions and plan roles and responsibilities before they attend actual events. Team members should also debrief after each event based on events during the resuscitation. The aim should be to discuss problems and concerns openly and allow learning and improvement in a constructive manner. Ideally this should be based on data collected during the event.

**Diagnosis of cardiac arrest**

Trained healthcare staff cannot assess the breathing and pulse sufficiently reliably to confirm cardiac arrest. Agonal breathing (infrequent and irregular gasps) is a pre-terminal event and common in the early stages of cardiac arrest. It should not be confused as a sign of life/circulation. Agonal breathing can also occur during chest compressions as cerebral perfusion improves, but is not indicative of a ROSC. In addition, immediately after cardiac arrest the sudden cessation of cerebral blood flow can cause an initial short seizure-like episode that can be confused with epilepsy.

Delivering chest compressions to a patient with a beating heart is unlikely to cause harm. However, delays in diagnosis of cardiac arrest and starting CPR will adversely effect survival and must be avoided.

**High quality CPR**
The quality of chest compressions during in-hospital CPR is frequently sub-optimal and interruptions are often prolonged.\textsuperscript{44} Even short interruptions to chest compressions can adversely impact on outcome and every effort must be made to ensure that continuous, effective chest compression is maintained throughout the resuscitation attempt. Chest compressions should commence at the beginning of a resuscitation attempt and continue uninterrupted apart from a brief pause for a specific intervention (e.g. rhythm check). Most interventions can be performed without interruptions to chest compressions. The team leader should monitor the quality of CPR, change the person providing chest compressions every 2 minutes (during rhythm assessment) or sooner if the quality of CPR is poor.

**Defibrillation strategy**

The length of the pre-shock pause (i.e. the interval between stopping chest compressions and delivering a shock) is inversely related to the chance of successful defibrillation. Every five-second increase in the duration of the pre-shock pause almost halves the chance of successful defibrillation, therefore it is critical to minimise the pause.\textsuperscript{45-48} The traditional lengthy ‘top-to-toe’ safety check (e.g. “head, middle, bottom, self, oxygen away”) performed after the defibrillator has charged and before shock delivery, will therefore diminish significantly the chances of successful defibrillation. The pre-shock pause can be substantially reduced by continuing compressions during charging of the defibrillator and by having an efficient team coordinated by a leader who communicates effectively. The safety check to avoid rescuer contact with the patient at the moment of defibrillation should be undertaken rapidly but efficiently. The post shock pause is minimised by resuming chest compressions immediately after shock delivery. The process of shock delivery should be achievable with less than a 5 second interruption to chest compressions.

Rescuers must not compromise on safety. Roles should be agreed by the team members before attending a cardiac arrest. Always plan actions before stopping chest compressions. If there are delays caused by difficulties in rhythm analysis or if individuals are still in contact with the patient as the shock is about to be delivered, restart chest compressions whilst plans are made to decide what to do when compressions are next stopped. Rescuers should wear gloves during CPR attempts but do not delay starting CPR if gloves are not immediately available.

Although there are no data supporting a three-shock strategy, it is unlikely that
chest compressions will improve the already very high chance of ROSC when defibrillation occurs immediately after onset of VF/pVT. In circumstances where rapid early defibrillation is feasible (e.g. cardiac catheter laboratory, in monitored cardiac surgery patients, patients who have a witnessed and monitored VF/VT and are already connected to a defibrillator) three rapid defibrillation attempts in quick succession, may achieve ROSC without the need for chest compressions.

National Cardiac Arrest Audit

All in-hospital cardiac arrests should be reviewed and audited. The National Cardiac Arrest Audit (NCAA) is a UK-wide database of in-hospital cardiac arrests and is supported by Resuscitation Council UK and the Intensive Care National Audit & Research Centre (ICNARC). NCAA monitors and reports on the incidence of, and outcome from, in-hospital cardiac arrests in order to inform practice and policy. It aims to identify and foster improvements in the prevention, care delivery and outcomes from cardiac arrest. Participating in NCAA enables hospitals to collect and contribute to national, standardised data on cardiac arrest, enabling local and national improvements in patient care.49-53

6. Accreditation of the 2015 Guidelines

NICE has accredited the process used by Resuscitation Council UK to produce its Guidelines development Process Manual. Accreditation is valid for 5 years from March 2015. More information on accreditation can be viewed at https://www.nice.org.uk/about/what-we-do/accreditation

7. References

3. Agency NPS. Establishing a standard crash call telephone number in


33. Liberman M, Lavoie A, Mulder D, Sampalis J. Cardiopulmonary resuscitation:


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