International Journal of Science and Research (IJSR)
ISSN: 2319-7064
SJIF (2022): 7.942

Cardiac Advanced Life Support (CALS)

Nandeesh Kumar P R

Lecturer, MSc Nursing (Medical Surgical Nursing), Cauvery College of Nursing, Mysuru, Karnataka, India

Abstract: ***Cardiopulmonary resuscitation (CPR) is a vital technique that can save lives in situations where the heart has stopped pumping blood. CPR involves chest compressions and rescue breaths that help maintain blood circulation and oxygen delivery to the brain and other organs. CPR should be initiated as soon as possible after cardiac arrest, as it can significantly increase the chances of survival and reduce the risk of brain damage. Nurses working in cardiovascular intensive care units (CVICUs) or mixed ICUs care for patients after heart surgery, including those who've undergone cardiac valve repairs, aneurysm repairs, pacemaker insertion, and coronary artery bypass grafting. To equip them with the skills and knowledge to handle clinically complex cases, they undergo training in advanced cardiac life support (ACLS). This enables them to provide timely and effective interventions for patients with cardiac emergencies.***

Keywords: Resuscitation, CPR, Cardiac Surgery, Cardiac Advanced Life Support, Resternotomy

1. Introduction

Figure 1: CPR (Cardiopulmonary Resuscitation)

The American Heart Association (AHA) ACLS guidelines build on the foundation of basic life support skills with more in-depth coverage of pharmaceuticals and the use of automated external defibrillators (AEDs). These guidelines require critical review and modification to ensure optimum resuscitation for patients who've undergone cardiac surgery or have implanted devices such as intra-aortic balloon pumps (IABPs) or mechanical circulatory support.

- Performing cardiopulmonary resuscitation on an adult who's had cardiac surgery can significantly damage the heart.
- The cardiac advanced life support (CALS) protocol is designed for use with patients after cardiac surgery (except those who've had pulmonary surgery) to correct reversible causes of arrest quickly.
- If necessary, immediate resternotomy can be performed by a trained physician.

Cardiac Advanced Life Support (CALS)

The CALS protocol, a cardiopulmonary resuscitation method developed for CVICUs, is designed for use with any patient who's had cardiac surgery, excluding those who've had pulmonary surgery. The goal of CALS is to correct any reversible causes of arrest quickly, followed, if necessary, by immediate resternotomy performed by a trained physician. When the absence of cardiac pressure and respiratory waveforms is identified, a first responder should initiate the CALS protocol. ECM can be deferred for 1 minute to allow for rapid defibrillation or pacing as indicated. ECM stands for extracorporeal membrane oxygenation, a life-saving technique that provides oxygen to the blood when the heart or lungs are failing. Patients with PEA arrests have electrical activity in their hearts, but no pulse or blood pressure. This means that their hearts are not pumping blood effectively to their vital organs. ECM can restore blood flow and oxygen delivery, and improve the chances of survival and neurological recovery. Therefore, ECM should be performed immediately on patients with PEA arrests, as any delay can worsen their outcomes.

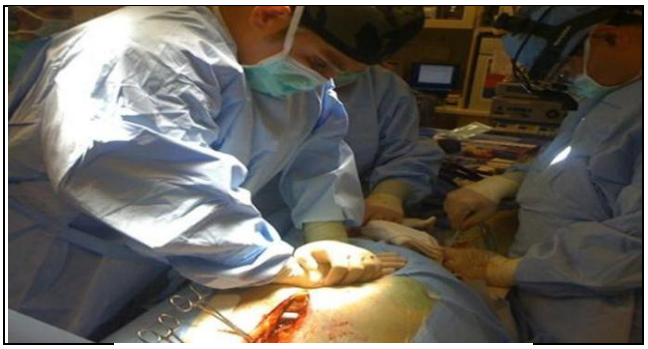

Figure 2: CPR during Cardiac Surgery

Cardiac Advanced Life Support CALS AHA Guidelines

CALS Algorithm

Follow the Cardiac Advanced Life Support algorithm when patients experience arrest after cardiac surgery.

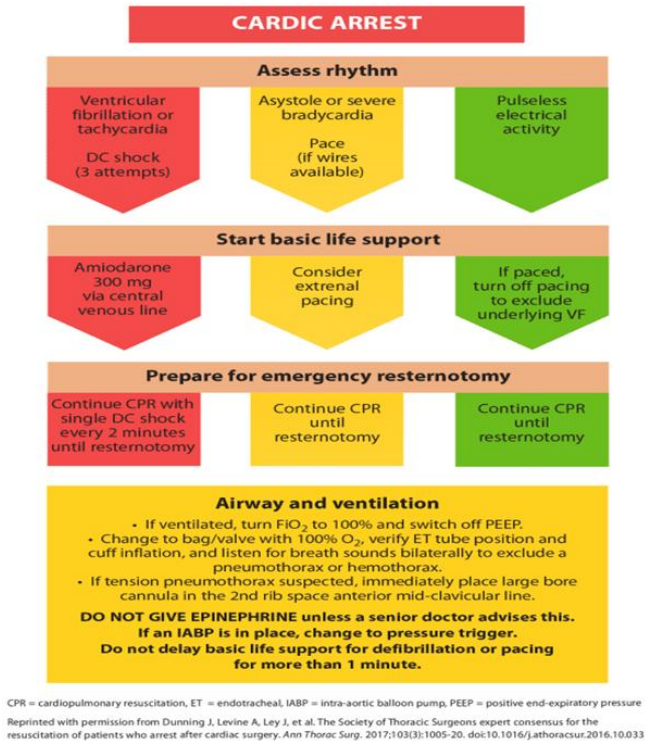

Figure 3: Cardiac Advanced Life Support Algorithm

The CALS protocol advises against full-dose epinephrine or 1 mg epinephrine for these patients to avoid significant hypertension, which could potentially harm fresh cardiac grafts. Resternotomy is required for 20% to 50% of patients who've had a cardiac arrest after cardiac surgery, but it's recommended only on postoperative Days 1 to 10 because pericardial adhesions might result in more harm when reopening the patient.

Key Roles

The Cardiac Advanced Life Support approach identifies the following six key roles for clinical staff:

External cardiac massage

- One team member performs external cardiac massage (ECM) at a rate of 100 to 120 compressions per minute to reach a mean arterial pressure (MAP) of 60 mmHg. Note: Switching team members every 2 minutes helps to ensure high-quality ECM.

Airway and breathing

- This team member increases oxygen supplementation to 100% and removes positive end-expiratory pressure. They assess the patient's airway and breathing to determine if the cause of arrest is a pneumothorax, hemothorax, or an endotracheal tube issue.

Defibrillation

- This team member attaches the defibrillator and administers shocks and pacing as required. They also ensure internal defibrillators are connected during resternotomy.

Team Leader

- This senior team member conducts resuscitation management and ensures protocols are followed correctly.

Drugs and Syringe Drivers

- One team member stops all infusions and administers other drugs as indicated by the team leader.

ICU Coordinator

- One member of the ICU staff coordinates other facilitating activities to help supplement resuscitation.

Cardiac Arrest Causes and Actions

Many cardiac arrest conditions are reversible. Determining and treating the cause is essential to optimizing patient outcomes.

Reversible Causes

Reversible causes of cardiac arrest include the following:

- Hydrogen ion excess (acidosis)
- Hypoglycemia
- Hypokalemia/hyperkalemia
- Hypothermia/hyperthermia
- Hypovolemia
- Hypoxia
- Tamponade
- Tension pneumothorax
- Thrombosis (pulmonary embolus/myocardial infarction)
- Toxins

According to the Society of Thoracic Surgeons, 0.7% to 8% of patients who've had cardiac surgery suffer from cardiac arrest. Ventricular fibrillation (VF), the most common cause, accounts for 25% to 50% of cardiac arrests. VF treatment begins with defibrillation—up to three shocks at 150 joules. ECM isn't recommended or beneficial before administering defibrillation. If a return of circulation isn't achieved after three shocks, begin ECM until a resternotomy can be performed.

For cardiac arrest caused by asystole or severe bradycardia, pace the patient. If the patient is attached to an epicardial pacemaker, set it to dual-chamber pacing at 80 to 100 beats per minute, or press the emergency pacing button. Attach a transcutaneous pacemaker to the patient if epicardial wires aren't in place.

If an intrinsic or pacing rhythm is noted on the ECG, but the patient is pulseless, begin ECM and prepare for

resternotomy. If neither a defibrillator nor pacing is feasible within 1 minute, start ECM at a rate of 100 to 120 beats per minute. To achieve a mean arterial pressure of 60 mmHg or higher, modify cardiac depressions.

Causes of arrest that can lead to VF, bradycardia, or asystole after cardiac surgery include hypovolemia or bleeding, graft or valve failure, low cardiac output, and tamponade. Due to the nature of cardiac surgery and the typical patient population, coagulopathy can occur as a result of residual heparin effects, platelet dysfunction, clotting factor deficiencies, or extensive fibrinolysis. Treatment with appropriate clotting factors or protamine can help reverse these causes.

Surgical bleeding can require surgical re-exploration. Bleeding most commonly occurs at sternal wire sites or anastomotic graft sites. Assess chest tube output for excess bleeding, and follow facility guidelines for provider notification and surgical re-exploration. Typically, chest tube output of >400 mL in the first hour, >200 mL in 2 consecutive hours, or >100 mL per hour in 4 consecutive hours should prompt re-exploration. Keep in mind that chest tube misplacement can mask bleeding and cause fluid collection. If a patient who's hemodynamically unstable shows low to no chest tube output, notify a provider to consider ordering a chest x-ray or transesophageal echocardiogram.

Cardiac tamponade is a life-threatening condition that happens when the pericardial sac fills up with fluid or blood and puts pressure on the heart. This prevents the ventricles from expanding fully and lowers the amount of blood that the heart can pump. Look for the Beck's triad, which are the three main signs of cardiac tamponade: low blood pressure, bulging veins, and quiet heart sounds. Arrhythmias or cardiac arrest can be the first signs of tamponade in these patients.

Airway and Breathing

If the patient is still on a ventilator when a cardiac arrest occurs, change the ventilator settings to an oxygen concentration of 100% and remove positive end-expiratory pressure to help decrease intrathoracic pressure and increase venous return. For patients without an endotracheal tube, apply a manual resuscitator with a rate of two ventilations for every 30 chest compressions. Consider causes of respiratory arrest such as hemothorax, pneumothorax, or improper endotracheal tube (ETT) placement by taking the following steps:

- Check ETT placement.
- Listen for air leaks and check cuff inflation.
- Look for fog formation in the ETT.
- Palpate the trachea for proper position.
- Assess for symmetrical chest rise and fall.
- Auscultate lung sounds for bilateral air entry.
- Check capnography readings for appropriate end-tidal carbon dioxide.

If a tension pneumothorax is identified, alert the physician. A large-bore cannula will be inserted by a skilled medical professional into the second intercostal gap at the midclavicular line.

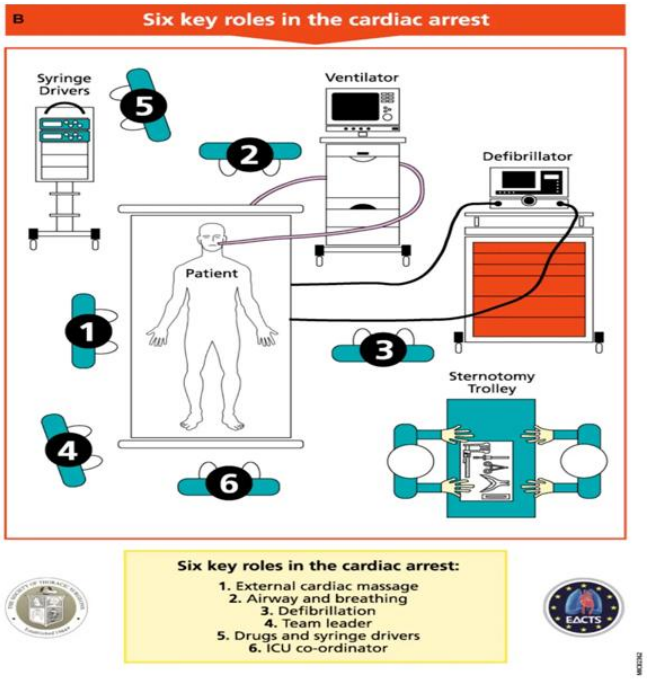

Figure 4: Six Key Roles in the Cardiac Arrest

Medications

If a cardiac arrest occurs, pause all vasoactive, ionotropic, chronotropic, and sedation infusions to remove any variables that could interfere with successful resuscitation. Epinephrine and vasopressin aren't recommended during resuscitation of patients after cardiac surgery. If necessary, only trained providers familiar with these medications should administer them. No evidence exists to support the use of atropine in patients experiencing bradycardia or asystole post-cardiac surgery. Amiodarone should be given to patients with VF or pulseless ventricular tachycardia after three unsuccessful defibrillation attempts. Start with a 300 mg bolus, followed by a 150 mg dose, then an infusion of 900 mg over 24 hours.

Sternal wound infection or sepsis can occur after a resternotomy, so administer an antiseptic washout and additional antibiotics as ordered.

Assistive Devices

Intra-aortic balloon pumps (IABPs) are a type of mechanical circulatory support that can reduce the oxygen demand of the heart and improve its blood supply. However, they can also pose a challenge in case of cardiac arrest, as they may interfere with chest compressions or defibrillation. Placed in the proximal descending aorta, just below the origin of the left subclavian artery, the balloon inflates during diastole and deflates during systole. It can be triggered by the ECG or arterial pressure waveforms. PEA can be difficult to identify in patients with an active pacemaker because the ECG will show a paced rhythm whether or not a patient has a pulse. Using the ECG trigger mode on an IABP will cause the balloon to pump in conjunction with the ECG reading, but using the pressure

trigger mode will cause it to pump in conjunction with the patient's actual pulse/pressure. For this reason, it's more accurate when performing CPR to use the pressure trigger mode with counterpulsation set at maximal augmentation during PEA when the patient has no pulse or pressure.

A left ventricular assist device (LVAD) is a mechanical pump that helps the left ventricle of the heart to circulate blood throughout the body. Some patients who have had cardiac surgery may need an LVAD implanted to support their heart function. These devices display pump flow, which can help identify loss of blood flow. Follow the CALS algorithm with these patients: defibrillate patients in VF, pace those in asystole, and start ECM on patients in PEA.

Resternotomy

If all causes of cardiac arrest have been considered and all attempts at non-ECM have been exhausted, resternotomy is recommended within 5 minutes to perform internal cardiac massage. Compared to ECM, internal cardiac massage performs better at achieving cardiac resuscitation by increasing coronary/end-organ blood flow and spontaneous circulation. ICUs should have a resternotomy kit or cart on standby to expedite this procedure. Kits should contain Scalpel, a wire cutter, needle holder, sterna retractor and suctioning equipment.

Special Considerations

For patients receiving heart, heart-lung, or double-lung transplants through a sternotomy, follow the CALS resuscitation recommendations. If patients come out of surgery with an open chest with packing and then experience cardiac arrest, perform ECM at the midpoint of the chest over the packs of gauze. Assess arterial pressure waveforms for effectiveness as less force may be required.

Therapeutic Hypothermia

Therapeutic hypothermia is an effective treatment for patients who are comatose after cardiac arrest and undergo a return of spontaneous circulation (ROSC). The goal is to maintain a core temperature between 32° C and 36° C (89.6° F and 96.8° F) for 24 hours. Lowering core temperatures helps to reduce cerebral metabolic demand by reducing the rate of oxygen consumption. Therapeutic hypothermia also reduces cerebral edema by preventing inflammatory cytokines from penetrating the blood brain barrier. If poor cerebral blood flow is assumed after resuscitation and achieving ROSC, consider therapeutic hypothermia.

Apply an Evidence-Based Approach

Although cardiac arrest after cardiac surgery is uncommon, all clinical staff caring for these patients should be aware of and familiar with the CALS approach for resuscitation. Consider all causes of cardiac arrest and treat them accordingly. Nursing units caring for these patients should have protocols in place and the necessary supplies to act with haste in the event of cardiac arrest. For efficiency, assign a team of six with key roles to help ensure successful resuscitation. All hospitals have protocols for cardiac resuscitation, but they also should consider the evidence-based CALS approach.

2. Conclusion

Cardiac arrest is a life-threatening condition that occurs when the heart stops pumping blood. This deprives the brain and lungs of oxygen and can cause death within minutes. CPR is a vital intervention that can restore blood flow and oxygen delivery by performing chest compressions and rescue breaths. CPR can increase the chances of survival until advanced medical care arrives.

The best outcome for a victim is contingent on early recognition, quick action and notification of medical professionals. Compression depth and recoil should be monitored along with proper ventilation rates and technique to increase survival chances. An automated external defibrillator (AED) is a device that can deliver an electric shock to the heart of a person who is in cardiac arrest. It is important to use an AED as soon as possible, because it can increase the chances of survival. If you witness someone collapse or become unresponsive, call 911 and look for an AED nearby. You may also need to perform cardiopulmonary resuscitation (CPR) on the person until help arrives. CPR is a technique that involves chest compressions and rescue breaths to keep blood and oxygen flowing to the vital organs. Don't be afraid to do CPR, because you can make a difference in saving someone's life. Just follow these steps: C-A-B. C stands for compressions, A stands for airway, and B stands for breathing.

1. **C**ompressions (100-120 per minute)
2. **A**irway (head-tilt and chin-lift)
3. **B**reathing (E-C clamp, barrier device)

References

[1] Applefield D, Krishnan S. Protamine. StatPearls. January 8, 2023. ncbi.nlm.nih.gov/books/NBK547753
[2] Brand J, McDonald A, Dunning J. Management of cardiac arrest following cardiac surgery. *BJA Educ*. 2018;18(1):16-22. doi:10.1016/j.bjae.2017.11.002
[3] Dunning J, Levine A, Ley J, et al. The Society of Thoracic Surgeons expert consensus for the resuscitation of patients who arrest after cardiac surgery. *Ann Thorac Surg.* 2017;103(3): 1005-20. doi:10.1016/j.athoracsur.2016.10.033
[4] Khan TM, Siddiqui AH. Intra-aortic balloon pump. StatPearls. June 3, 2022. ncbi.nlm.nih.gov/books/NBK542233
[5] Merchant RM, Topjian AA, Panchal AR, et al. Part 1: Executive summary: 2020 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. *Circulation*. 2020;142:S337-57. doi:10.1161/CIR.0000000000000918
[6] Oliver TI, Sadiq U, Grossman SA. Pulseless electrical activity. StatPearls. January 23, 2023. ncbi.nlm.nih.gov/books/NBK513349/

[7] Pacha HM, Soud M, Alraies MC. Beyond Beck's Triad: A rare cause of cardiac tamponade and hemoptysis. *Ochsner J*. 2018;18(3):271-3. doi:10.31486/toj.17.0081
[8] American Nurse Journal. 2023; 18(7). Doi: 10.51256/ANJ072314
[9] https://cpr.heart.org/en/resources/what-is-cpr
[10] https://www.researchgate.net/figure/Six-key-roles-in-management-of-cardiac-surgical-arrest-Abbreviation-ICU-intensive-care_fig1_274397435
[11] https://cprcertificationnow.com/pages/cpr-aed-first-aid-cpr-conclusion
[12] https://www.cdc.gov/heartdisease/cpr.htm#:~:text=Cardiopulmonary%20resuscitation%20(CPR)%20is%20an,including%20the%20brain%20and%20lungs