The Australasian ANZSCTS/ANZICS guidelines on cardiothoracic advanced life support (CALS-ANZ)

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Every year, more than 15,000 patients undergo cardiac surgery in Australia and New Zealand. The overall incidence of cardiac arrest after cardiac surgery is between 0.7% and 5.2%. Most cardiac arrests occur within 24 hours of surgery, with up to 50% occurring in the first 3 hours following intensive care unit (ICU) admission. Compared with other in-hospital cardiac arrests, survival in this patient population is high (75% vs 39%). The reasons for this include the high degree of cardiac monitoring; a high proportion of reversible causes, such as pericardial tamponade or haemorrhage, and the effects of internal cardiac massage. The application of standard advanced life support protocols in post-surgical cardiothoracic patients may lead to avoidable adverse events, and hence, specific resuscitation protocols have been developed and established in Europe and North America.

Development of the CALS-ANZ guidelines

These guidelines are based on a consensus established in a binational, multiround Delphi survey among senior clinicians in Australia and New Zealand and have been endorsed by the Australian and New Zealand Society of Cardiac and Thoracic Surgeons (ANZSCTS) and the Australian and New Zealand Intensive Care Society (ANZICS).

Methods

The guidelines were developed using a Delphi consensus as well as a systematic literature review. The Delphi method is a survey among an expert panel in an iterative structured manner. The expert panel consisted of specialists in the fields of intensive care, cardiac anaesthesia and cardiac surgery, as defined below. The investigator group consisted of the medical leads for CALS-ANZ (CK, CJ, TS and DM), the nursing lead for CALS-ANZ (AR) as well as the medical leads for CALS-UK (JD and AL).

Invitations to participate, along with information on the consensus project were distributed through electronic mailing lists of the relevant bodies:

- ANZSCTS;
- the Cardiac Thoracic Vascular and Perfusion (CTVP) Special Interest Group of the Australian and New Zealand College of Anaesthetists (ANZCA);
- ANZICS; and
- the College of Intensive Care Medicine of Australia and New Zealand (CICM).

Clinicians were eligible to participate in this study if they were specialists holding an Australasian specialist qualification in cardiac surgery, (cardiac) anaesthesia or intensive care (or a combination thereof), and primarily practising in Australia or New Zealand. This ensured that the consensus obtained would be particularly valid in this geographic region and its health care systems. Seventy-nine clinicians participated as expert panellists in the study. The breakdown by clinical specialty and location is shown in Table 1.

Statements were presented to the panellists for rating on a 5-point Likert scale (strongly disagree, disagree, neither disagree nor agree, agree, strongly agree). Rating was compulsory for each statement. In addition, panellists could suggest categories and items in the comment section for each item. These were included as new items in the subsequent round. The first set of items was generated from the guidelines of the Society of Thoracic Surgeons Task Force on Resuscitation After Cardiac Surgery and a systematic literature review conducted by the investigators CK and CJ.

An investigator meeting via teleconference was held after each round. The investigators reviewed the results and free text comments in anonymised fashion and determined changes to wording of items by majority vote. Significant changes in the wording of items were re-presented to the panellists in a subsequent round. Likewise, thematically similar items could be combined and re-polled. Items could be accepted without re-polling if the change in wording was considered minor and was considered not to be changing the notion of the item. The analysis of each round was subsequently presented to the panellists in anonymised form along with their own answers and additional or modified items via email.

Rules for approval and rejection of statements were predefined. Statements required approval by ≥ 75% of the
The CALS-ANZ algorithm begins with an assessment of the patient's rhythm and has three distinct treatment pathways (Online Appendix, section 7):

- If the patient is in pulseless ventricular tachycardia or ventricular fibrillation cardiac arrest, adhesive defibrillator pads are attached and up to three stacked shocks are delivered.
- If the patient is in asystole or severe bradycardia with epicardial pacing wires in place, the patient is paced in DOO mode.
- If the patient is in pulseless electrical activity arrest and is paced the time of the arrest, the pacemaker is briefly paused to exclude underlying ventricular fibrillation (which would require defibrillation).

During this initial phase of assessment and management, external chest compressions may be withheld for up to 60 seconds (Online Appendix, section 7).

**Emergency resternotomy**

If the above measures fail to establish return of spontaneous circulation, a resternotomy is to be performed. Preparation for the emergency resternotomy should commence immediately at the time of the arrest, including two or three staff members putting on gowns and preparing the emergency resternotomy set (Online Appendix, section 10.2).

An emergency resternotomy should be an integral part of the CALS arrest management for all patients within 10 days of their last operation. Beyond the tenth postoperative day, a senior clinician should decide whether emergency resternotomy is to be performed (Online Appendix, section 10.1).

**Resternotomy procedure**

After removing the sternotomy dressing, a one-piece adhesive surgical drape is placed on the patient's chest without prior skin preparation (Online Appendix, section 10.4).
Figure 1. The Australasian cardiothoracic advanced life support (CALS-ANZ) algorithm

BVM = bag-valve-mask; CALS = cardiothoracic advanced life support; CPR = cardiopulmonary resuscitation; DCR = direct current cardioversion; ETT = endotracheal tube; Fio₂ = fraction of inspired oxygen; iv = intravenous; PEA = pulseless electrical activity; VF = ventricular fibrillation; VT = ventricular tachycardia.
A short period of sterile external cardiac massage may be required until all of the resternotomy equipment is ready (Figure 2).

After cutting skin sutures and removal of sternal closure devices (wires, plates, cables), a retractor is inserted to allow for exposure of the heart. The pericardium may have to be reopened if closed. Chest reopening should be completed within 5 minutes from the onset of circulatory arrest (Online Appendix, section 10.1). Any blood clots are carefully removed, internal cardiac massage is commenced using the two-handed technique (Online Appendix, section 10.6) and, if in a shockable rhythm, the heart is defibrillated with 20 joules using internal defibrillator pads.

Team role allocations

Effective teamwork is an essential component of successful emergency management. The CALS-ANZ protocol defines clear role allocations and each of those roles should be taken by an appropriately trained team member. Individual roles and teamwork should be regularly practised in interprofessional and interdisciplinary simulation training (Online Appendix, section 10.2). The six key roles are team leader, ICU coordinator, resternotomy team (generally two staff members), resternotomy trolley, defibrillator and pacing, and airway and breathing (Figure 3).

Airway management

In the CALS-ANZ protocol, standard principles to address any problems related to the patient’s airway or ventilation apply. If the patient is not intubated at the time of the cardiac arrest, ventilation should initially be performed via bag-valve-mask or supraglottic airway, with a fraction of inspired oxygen ($F_{iO_2}$) of 1.0. Endotracheal intubation should not delay attempts to address reversible causes or chest reopening and is best performed once the resternotomy is completed or return of spontaneous circulation (ROSC) is restored (Online Appendix, section 8).

Drugs and infusions

Cardiac arrests in patients after cardiac surgery are often quickly reversible and circulating standard advanced life support doses of epinephrine/adrenaline (ie, 1 mg intravenous) can therefore cause excessive hypertension and arrhythmias when achieving ROSC. Therefore, only small doses of adrenaline (eg, 50–100 mg intravenous) should be given. Amiodarone should be considered for refractory shockable rhythms (Online Appendix, section 11.1).
Drugs, adverse reactions as well as inadvertent bolus administration of vasodilatory drugs, including sedatives and analgesics, may precipitate a cardiac arrest. Therefore, all pre-arrest infusions should be paused and checked for drug or infusion errors (Online Appendix, section 11.2).

Return of spontaneous circulation

While not explicitly surveyed in the consensus process, we suggest the following strategy in case of ROSC at any stage of the resuscitation:

- If ROSC occurs before commencing a resternotomy, the team should continue preparing for a resternotomy and remain in attendance until the patient’s condition is deemed stable.
- If ROSC occurs during the resternotomy, it is reasonable to complete the removal of sternal closing devices and then remain in attendance until a cardiac surgeon arrives.

Summary

The incidence of cardiac arrests following cardiac surgery is very low, and immediate, effective resuscitation is associated with improved outcomes. We recommend regular interprofessional and interdisciplinary team training of the management of cardiac arrests in cardiothoracic patients in appropriate courses.

The CALS-ANZ guidelines are based on broad multidisciplinary consensus among Australasian cardiac surgeons, cardiac anaesthetists, and intensivists. The recommendations were produced by applying pragmatic accepted methodology, and consensus was achieved on most items. It is important to note that most of the literature on the topic originates from outside of Australasia and the evidence is generally of low grade. Therefore, the consensus is predominantly based on expert opinion evidence. The Australasian guidelines largely reflect those published for the Europe (2009) and North America (2017).

In the future, research efforts should be undertaken to establish an Australasian cardiac arrest management registry for patients following cardiac surgery.

Competing interests

Joel Dunning and Adrian Levine disclose a relationship with CALS-S UK Ltd. All other authors declare that they do not have any potential conflict of interest in relation to this manuscript.

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References


