Applied Cardiopulmonary Pathophysiology 16: 113-118, 2012

The new 2010 ERC resuscitation guidelines – Relevance for cardiac surgery patients

Jan Runte, Julika Schön, Armin Frank, Frank Hackmann, Hauke Paarmann, Matthias Heringlake

Department of Anesthesiology, University of Luebeck, Germany

Abstract

Postoperative cardiac arrest has been reported to occur in 0.7 to 2.9% after cardiac surgical procedures and may be related to ventricular fibrillation, major bleeding, cardiac tamponade, (tension) pneumothorax, failure of epicardial pacemaker leads, and surgery specific complications. Recent experimental data show improved resuscitation efficiency (improved coronary blood flow, more effective defibrillation, lower complication and higher survival rates) during open chest conditions and that patients after cardiac surgery benefit from early rethoracotomy if the circulation cannot be restored immediately after a cardiac arrest.
Based on these findings, the latest guidelines for Cardiopulmonary Resuscitation published by the European Resuscitation Council (ERC) in 2010 included a detailed chapter on resuscitation of patients with cardiac arrest after cardiac surgery procedures and suggest that, if conventional basic and advanced cardiopulmonary life support fail to achieve hemodynamic stabilization within 5 minutes after arrest, a rethoracotomy shall be performed immediately by any intensive care specialist and that this shall not necessarily be performed in the operation theatre but may also be accomplished bedside on the intensive care unit. The guidelines recommend a dedicated set of surgical instruments for rethoracotomy and that personal treating patients after cardiac surgery needs to be instructed and trained to fulfil rethoracotomy successfully.
Intensive care units (ICU) that have adopted these guidelines as standard operating procedures are mostly lead by cardiac surgeons. It is presently unknown whether ICUs driven by anaesthesiologists perform comparably when facing a cardiac arrest.

Key words: resuscitation, ERC guidelines 2010 section 8, cardiac arrest, cardiac surgery, rethoracotomy, internal cardiac massage

Introduction

In November 2010 the European Resuscitation Council (ERC) issued the latest edition of guidelines for cardiopulmonary resuscitation. Important changes have been made in the detailed section on resuscitation of patients with cardiac arrest after cardiac surgery (1), recommending early rethoracotomy for all patients with cardiac arrest in which no stable circulatory situation can be established within 5 minutes.

Almost 250,000 patients in more than 450 centres undergo cardiac surgery in Europe per year (2). The incidence of cardiac arrest after cardiac surgery has been reported to be around 0.7-2.9% (3-11). Seventeen to 79% of cardiac surgery patients suffering a

perioperative cardiac arrest survive to hospital discharge; a higher percentage than after a cardiac arrest in other clinical settings. This may be related to the fact that many factors leading to cardiac arrest during and after cardiac surgery (i.e.: ventricular fibrillation, major bleeding, and tamponade) may be quickly relieved by prompt resuscitation and emergency rethoracotomy. The latest ERC guidelines postulate early rethoracotomy and open chest resuscitation as an integral component of advanced cardiac life support (ACLS) for this group of patients.

Historical development

It is not new to perform rethoracotomy to resuscitate patients with cardiac arrest. Hake et al published the first description of open chest resuscitation in 1874 (12). Keen et al. published a series of two men with cardiac arrest in 1904 undergoing thoracotomy and internal heart compression (13). Within the beginning of the 20th century, a few more case reports about internal cardiac massage in patients with cardiac arrest, mostly leading to a poor outcome (14-17).

In 1960 Kouwenhoven et al. were the first to describe a new method of resucitation closed chest cardiac massage (Fig. 1), and in an observational study in 20 patients this new method lead to an overall survival of 70% (18). Since this landmark study, closed chest compression is the accepted standard in resuscitation to start from.

In 1965 Del Guercio and coworkers for the first time compared systemic blood flow during external and internal cardiac massage (19) and showed a better blood flow during internal cardiac massage. A finding later on supported by various studies (20-22). In 1981, Fairman et al. was the first to recommend emergency rethoracotomy in the intensive care unit after a cardiac surgery operation (23), followed by an increasing number of studies analysing myocardial perfusion during internal and external heart massage

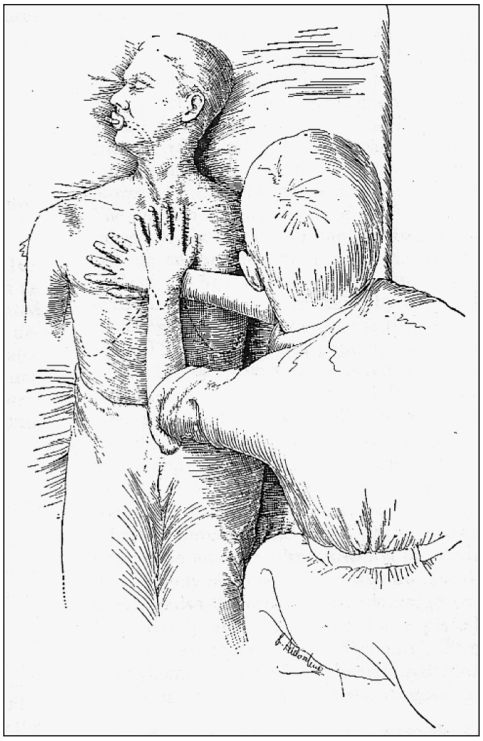

Figure 1: First description of closed chest cardiac massage with two-hand technique (14)

(24-25), when to start open chest cardiopulmonary resuscitation (26), and calls for guidelines on open chest cardiac massage in patients with cardiac arrest after cardiac surgery (3, 27). Sanders et al. showed a significantly higher coronary perfusion pressure during internal heart massage (24). He also pointed out that rethoracotomy has to be performed early to achieve higher survival rates (26).

In 2001 Dimopoulou et al. published a 4-year prospective study on the functional status and quality of life in long-term survivors of cardiac arrest after cardiac surgery (28). Half of these patients needed internal cardiac massage after rethoracotomy was performed. These authors presented a survival rate of 97% after cardiac arrest, 93% of the patients could be discharged from hospital, and after 4 years 55% of the patients were still alive. Of the survivors, more than 90% were capable of living a normal life.

After Dunning et al. had structured a 3-day training course called "The Cardiac Surgery Advanced Life Support Course (CALS)" (29) he published the first *guidelines* about managing cardiac arrest after cardiac surgery procedures in 2009. These guidelines pointed out, that early rethoracotomy is strongly recommended in the early phase of resuscitation if no stable circulatory situation can be established. They also postulated six key roles during resuscitation on the intensive care unit (ICU) and that six different persons with different functions can be identified: One person for external cardiac massage, one person for airway-management and breathing, one person for defibrillation, one person as the team leader, one person for drug administration, and a sixth person as the ICU co-ordinator calling for expert assistance, preparing for potential rethoracotomy, and further decisions. As depicted in figure 2, two or three persons are needed for early and fast retho-

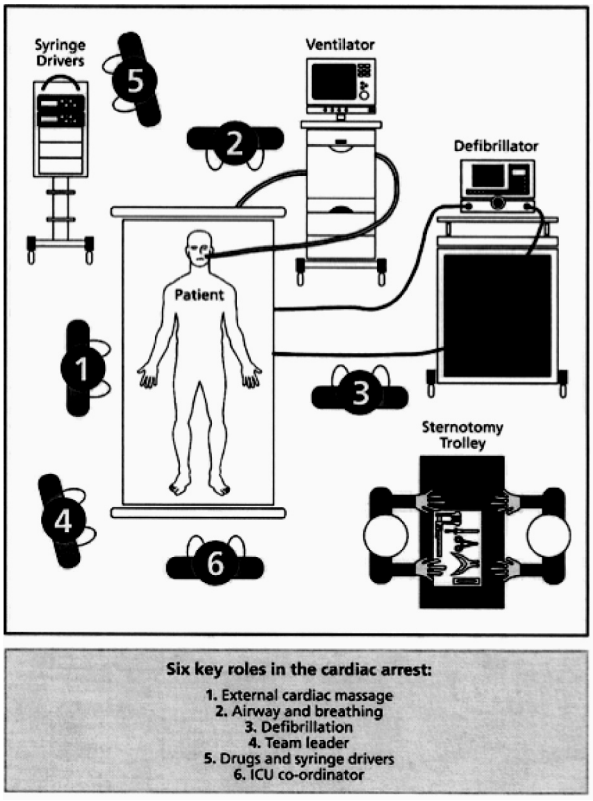

Figure 2: Six Key roles in the cardiac arrest (22)

racotomy (30). An easy to use and modified rethoracotomy set needs to be available on the ICU and all personal needs to be well trained using this set. Besides, the guidelines also emphasize the need for regular staff training with special resuscitation mannequins (for example Little Anne®, Laerdal Medical, Wappingers Falls, NY, USA). This article is one of the key publications for the newest ERC guidelines issued in 2010.

Recent guidelines

While former versions of the ERC guidelines did not specifically address the care of cardiac surgical patients, section 8h of the latest ERC guidelines (1) now details specific and reversible causes for this complication (pericardial tamponade, hypovolemia, myocardial ischaemia, (tension) pneumothorax, arrhythmias, and dysfunction of epicardial pacemaker stimulation) with a good prognosis, and gives a clear indication of early rethoracotomy in patients with cardiac arrest if hemodynamic stabilization cannot be achieved immediately.

Emergency rethoracotomy shall be performed within 5 minutes in patients with cardiac arrest after potentially reversible causes have been excluded and no sufficient circulation can be established with external chest compression or defibrillation/cardioversion. The following steps are strongly recommended:

1. If the patient is ventilated turn FiO_2 to 100% and switch off the positive end expiratory pressure (PEEP). If the patient is not ventilated perform endotracheal intubation promptly.
2. Initiate (and continue) external chest compression.
3. If there is ventricular fibrillation or ventricular tachycardia perform external defibrillation/cardioversion at a max of 3 times.
4. If an epicardial pacemaker is present turn to 100 beats/minute in the DDD or VVI-mode. If an intra-aortic blood pump (IABP) is present, change to pressure trigger.
5. If the patient has a (tension) pneumothorax perform cannulation of the 2nd rip space anterior mid-clavicular line.
6. Perform rethoracotomy without delay.

All intensive care personal needs to be trained in emergency rethoracotomy. The procedure shall not necessarily be performed by a surgeon, if a cardiac surgeon is not readily available. The ERC guidelines strongly suggest not to waste time by transfering the patient back to operation theatre and to perform a necessary rethoracotomy immediately, even in the patient's bed. Additionally, to improve the performance, the guidelines suggest to simplify the surgical instruments.

Summary

According to the new guidelines for cardiopulmonary resuscitation published by the European Resuscitation Council, rethoracotomy is recommended for all patients with cardiac arrest following cardiac surgery within 5 minutes after the event, if no stable circulatory situation has been achieved and potentially reversible reasons for cardiac arrest have been ruled out or been treated.

All medical specialities involved in the care of cardiac surgical patients (cardiac surgeon, intensive care specialist, anaesthesiologist and nursing staff) need to do training constantly to be prepared for these situations and to avoid any delay in achieving effective internal cardiac massage and thereby better survival rates. Intensive care units treating patients after cardiac surgery need to develop standard operation procedures for their local setting. The set for rethoracotomy shall be simple and clearly arranged.

References

1. Soar J, Perkins GD et al. European Resuscitation Council Guidelines for Resuscitation 2010 Section 8. Cardiac arrest in special circumstances: Electrolyte abnormalities, poi-

soning, drowning, accidental hypothermia, hyperthermia, asthma, anaphylaxis, cardiac surgery, trauma, pregnancy, electrocution. Resuscitation 81(10): 1400-33
2. Unger F. European survey on cardiac interventions: open-heart surgery, percutaneous transluminal coronary angioplasty and cardiac catheterization in 1993. A preliminary report by the Institute for Cardiac Survey of the European Academy of Sciences and Arts. Cardiovasc Surg 1995; 3 (6): 569-71
3. Pottle A, Bullock I et al. Survival to discharge following open chest cardiac compression (OCCC). A 4-year retrospective audit in a cardiothoracic specialist centre – Royal Brompton and Harefield NHS Trust, United Kingdom. Resuscitation 2002; 52 (3): 269-72
4. Mackay JH, Powell SJ et al. Six-year prospective audit of chest reopening after cardiac arrest. Eur J Cardiothorac Surg 2002; 22 (3): 421-5
5. Birdi I, Chaudhuri N et al. Emergency reinstitution of cardiopulmonary bypass following cardiac surgery: outcome justifies the cost. Eur J Cardiothorac Surg 2000; 17 (6): 743-6
6. el-Banayosy A, Brehm C et al. Cardiopulmonary resuscitation after cardiac surgery: a two-year study. J Cardiothorac Vasc Anesth 1998; 12 (4): 390-2
7. Anthi A, Tzelepis GE et al. Unexpected cardiac arrest after cardiac surgery: incidence, predisposing causes, and outcome of open chest cardiopulmonary resuscitation. Chest 1998; 113 (1): 15-9
8. Charalambous CP, Zipitis CS et al. Chest reexploration in the intensive care unit after cardiac surgery: a safe alternative to returning to the operating theater. Ann Thorac Surg 2006; 81 (1): 191-4
9. Wahba A, Gotz W et al. Outcome of cardiopulmonary resuscitation following open heart surgery. Scand Cardiovasc J 1997; 31 (3): 147-9
10. Kaiser GC, Naunheim KS et al. Reoperation in the intensive care unit. Ann Thorac Surg 1990; 49 (6): 903-7; discussion 908
11. McKowen RL, Magovern GJ et al. Infectious complications and cost-effectiveness of open resuscitation in the surgical intensive care unit after cardiac surgery. Ann Thorac Surg 1985; 40 (4): 388-92
12. Hake TG. Studies on ether and chloroform from Prof. Shiff's physiological laboratory. Practitioner 1874; 12: 241-50
13. Keen WW. A case of total laryngectomy and a case of abdominal hysterectomy in both of which massage of the heart for chloroform collapse was employed, with notes of 25 other cases of cardiac massage. Ther Gaz 1904; 28: 217-30
14. Killick EM, Eve FC. Physiological investigation of Rocking method of artificial respiration. Lancet 1933; 2: 740-42
15. Eve FC. Artificial circulation produced by Rocking: its use in drowning and anaesthetic emergencies. Brit M J 1947; 2: 295-96
16. Stephenson HE Jr., Reid LC et al. Pitfalls, precautions, and complications in cardiac resuscitation: study of 1,200 cases. AMA Arch Surg 1954; 69 (1): 37-53
17. Turk LN 3rd, Glenn WW. Cardiac arrest; results of attempted cardiac resuscitation in 42 cases. N Engl J Med 1954; 251 (20): 795-803
18. Kouwenhoven WB, Jude JR et al. Closed-chest cardiac massage. JAMA 1960; 173: 1064-7
19. Delguercio LR, Feins NR et al. Comparison of Blood Flow during External and Internal Cardiac Massage in Man. Circulation 1965; 31: SUPPL 1:171-80
20. Jackson RE, Freeman SB. Hemodynamics of cardiac massage. Emerg Med Clin North Am 1983; 1 (3): 501-13
21. Babbs CF. Hemodynamic mechanisms in CPR: a theoretical rationale for resuscitative thoracotomy in non-traumatic cardiac arrest. Resuscitation 1987; 15 (1): 37-50
22. Boczar ME, Howard MA et al. A technique revisited: hemodynamic comparison of closed- and open-chest cardiac massage during human cardiopulmonary resuscitation. Crit Care Med 1995; 23 (3): 498-503
23. Fairman RM, Edmunds LH Jr. Emergency thoracotomy in the surgical intensive care unit after open cardiac operation. Ann Thorac Surg 1981; 32 (4): 386-91
24. Sanders AB, Ogle M et al. Coronary perfusion pressure during cardiopulmonary resuscitation. Am J Emerg Med 1985; 3 (1): 11-4
25. Gazmuri RJ, Becker J. Cardiac resuscitation. The search for hemodynamically more effective methods. Chest 1997; 111 (3): 712-23

26. Sanders AB, Kern KB et al. Time limitations for open-chest cardiopulmonary resuscitation from cardiac arrest. Crit Care Med 1985; 13 (11): 897-8
27. Guidelines 2000 for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Part 6: advanced cardiovascular life support: section 4: devices to assist circulation. The American Heart Association in collaboration with the International Liaison Committee on Resuscitation. Circulation 2000; 102 (8 Suppl): I105-11
28. Dimopoulou I, Anthi A et al. Functional status and quality of life in long-term survivors of cardiac arrest after cardiac surgery. Crit Care Med 2001; 29 (7): 1408-11
29. Dunning J, Nandi J et al. The Cardiac Surgery Advanced Life Support Course (CALS): delivering significant improvements in emergency cardiothoracic care. Ann Thorac Surg 2006; 81 (5): 1767-72
30. Dunning J, Fabbri A et al. Guideline for resuscitation in cardiac arrest after cardiac surgery. Eur J Cardiothorac Surg 2009; 36 (1): 3-28

Correspondence address
Jan Runte, M.D.
Department of Anesthesiology
University of Luebeck
Ratzeburger Allee 160
23538 Luebeck
Germany
jan.runte@uk-sh.de