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EC EMERGENCY MEDICINE AND CRITICAL CARE
Research Article

Cardiac Arrest in Cardiac Surgery Intensive Care Unit: A Pilot Study on Crisis Resource Management Course

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Received: June 28, 2019; **Published:** July 12, 2019

Abstract

Introduction: Postoperative cardiac arrest in cardiac surgery occurs in 8% of cases and the causes are mainly attributable to bleeding, acute myocardial infarction, hypertensive pneumothorax, failure of epicardial pacing. [1,2]. The technical skills represent the manual capacity, while the non-technical skills relate to skills that in the course of aeronautical and medical history have represented the basis of fatal accidents, such as the case of Tenerife or the care case of Elaine Bromiley. From the document "To Err is Human" the CRM has been adopted in the healthcare world and implemented over twenty years, creating the crisis resource management [3]. In according to CRM programme, a course was created to manage the cardiac arrest and the emergency chest re-opening in cardiac surgery intensive care unit with the focus on the reduction of clinical time of recognition, of intervention and of preparation to the chest re-opening at bedside.

Materials and Methods: A two-day course was established in advanced life support (ALS) in cardiac patient, in particular in cardiac surgery intensive care units (CSICU) ward. The pilot course had frontal lessons and high-fidelity simulation at a CSICU bed. The course ended by validating the knowledge acquired through multiple choice questions and from the continuous observation during simulation in which it was possible to assess the health care providers.

Results: 23 nurses, 2 anesthesiologists, 2 anesthesia physician students participated in the course. They were videographed during the execution of the simulations. From the videos analysis, a reduction of time on all emergency steps was observed, in particular the bedside preparation to the emergency surgery, with open chest cardiopulmonary resuscitation or bleeding control. Another focus was on non-technical skills, in which the principles of CRM as team work, communication, decision making, leadership were increased simulation by simulation.

Discussion: Despite the debate still open on the effectiveness of CRM, in our experience we have been able to observe how, in addition to reducing the timing of care, has increased various non-technical skills, such as stress management and situational awareness.

Keywords: *Cardiac Arrest; Cardiac Surgery; Intensive Care Unit; Crisis Resource Management; High Fidelity Simulation*

Introduction

The cardiac arrest after cardiac surgery has an incidence of 0.7 - 8% and it occurs especially in the immediate post-operative period. The specific causes are hypovolaemia, myocardial ischemia, cardiac tamponade, pacing failure and/or tension pneumothorax. If they are recognized, a successful resuscitation and a high survival rate can be achieved [2].

The European Council of Resuscitation Guidelines and the Society of Thoracic Surgeons (STS) Clinical Practice Guidelines reports the resuscitation indications, such as the emergency re-sternotomy within five minutes, the vital parameters to be observed for cardiopulmonary resuscitation (CPR) to be effective (Table 1), alternative techniques such as ECMO, healthcare providers in advanced life support in cardiac surgery, roles and responsibilities.

Indications	Temporal limits
• CPA in post cardiac surgery • Hypovolaemia • Myocardial Infarction • Systolic pressure <60 mmHf during external chest compressions	• < 5 min by CPA starting • < 10 postoperative days • Senior surgical decision after 10 postoperative days

Table 1: *The society of thoracic surgeons (STS) clinical practice guidelines indication to re-sternotomy.*

Cardiopulmonary resuscitation in patient undergone to cardiac surgery has changes respect to other in-hospital setting. In particular the emergency management can be divided in three phases: the assessment, the basic/advanced life support, the emergency re-sternotomy.

The first minute of resuscitation represents the assessment and basic life support in cardiac surgery in which there is the first attempts that must be performed, such as defibrillation in VF/VT with three consecutive electrical shocks, epicardial pacing in asystole and there represent the basic life support, followed by the advanced life support, with the pharmacological administration, the external pacing, the pacing switch off in the case of the PEA to recognize a possible VF [1].

The next step is the preparation for the emergency chest re-opening and possible extracorporeal resuscitation support (ECLS) (Figure 1 and 2).

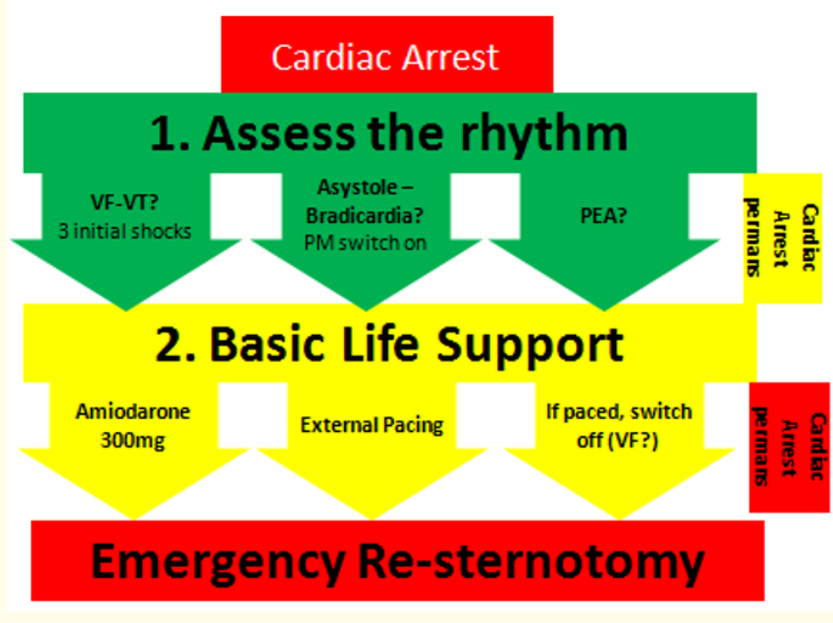

Figure 1: *The society of thoracic surgeons (STS) algorithm for cardiac arrest in cardiac surgery.*

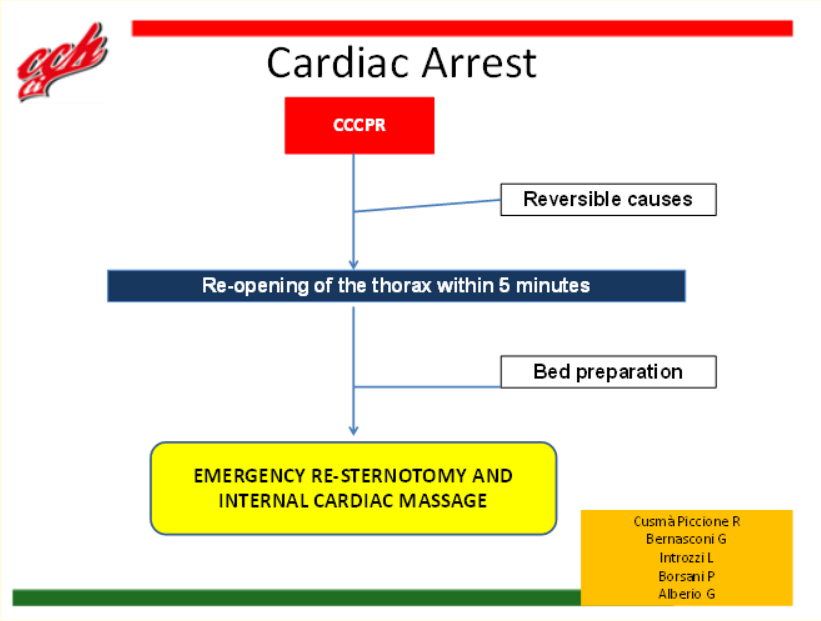

Figure 2: *From closed chest cardiopulmonary resuscitation (CCCR) to re-sternotomy.*

Human factors have been studied in the field of aviation: the first report in which they are mentioned dates back to 1934, due to an accident of a "too technological" aircraft for man. Later, several air accidents occurred, in particular the famous air disaster in Tenerife in 1977, in which the human factors emerged as the basis of the disaster, in addition to a technology and an environment unfavorable to the best flight conditions. Following these incidents, NASA and FAA set up a program to increase technical and non-technical skills, involving pilots, co-pilots and flight attendants, analyzing the main weaknesses of the technical skills (TS) and non-technical skills (NTS) at the base of the accidents: the crew resource management (CRM) [4,5].

In healthcare, the problem of human factors was born with the report "To err is Human", where the statistics have brought to light many medical errors due to undeveloped NTS. This report led former President Clinton to direct American health care to a program set up at the aeronautical CRM [6].

The healthcare pathway has seen NTS for professionals, such as anesthesiologists, surgeons and scrubs [7-9] and several other NTS development programs have seen done, reaching a number of 17 non-technical skills [10] and the creation of CRM courses, which have increased safety in clinical practice over a period of twenty years [3].

Materials and Methods

A two-day course was established to treat the Advanced Life Support in Cardiac Surgery Intensive Care Unit. In both days plenary lectures, specific workshops and high fidelity simulation were organized.

On the first day the algorithm was developed according to the ERC 2015 and STS 2017 guidelines in the field of cardiac surgery, in particular the treatment up to emergency re-sternotomy, electrocardiography, airway management; on the second day, the topics covered were extracorporeal life support, the chest re-opening in intensive care, the ECMO support.

In both days the theory was followed by practice: high fidelity simulations were organized, setting up an intensive care unit bed, applying the ALS manikin simulator and the monitor simulator normally used in everyday clinical practice. The material used for the clinical simulation was the material specifically stored in dedicated carts and positioned in the daily location on the ward.

The simulation sessions were structured with the number of staff employed daily during the shift of three nurses on the ward, while an anesthesiologist and a heart surgeon were absent until the call for help (Figure 3).

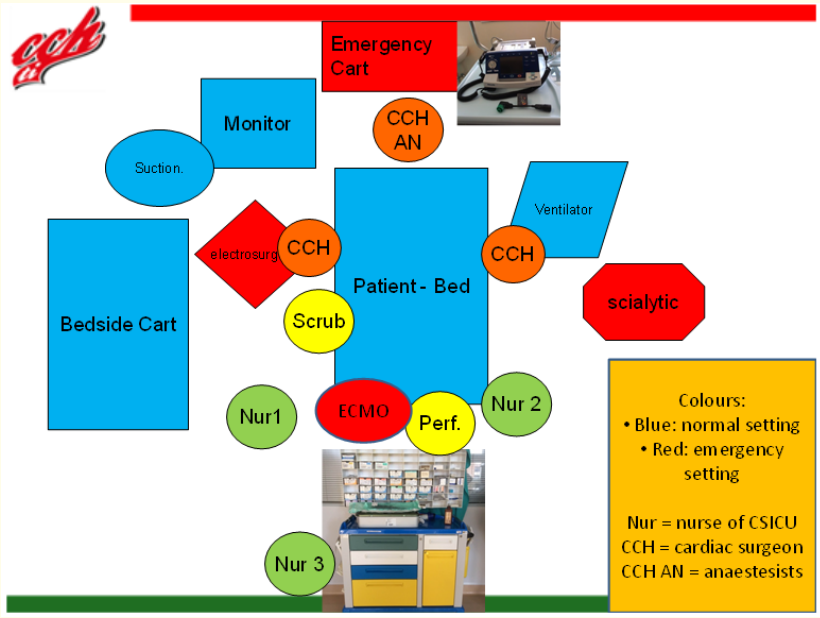

Figure 3: *Bedside crisis resource management.*

During the simulations, the participants and the instructors were filmed for debriefing through two environmental cameras at two different points.

The instructor were a cardiac anesthetist, ALS ERC instructor, a critical care nurse, ALS ERC instructor, a critical care nurse specialized in operating room and a cardiac surgeon. The health care providers of cardiac surgery intensive care unit, the cardiac surgeons, the cardiac anaesthesiologists and the operating room nurses (scrub nurses and anesthesia nurses) were included.

Perfusionists were not included for organizational problems.

Results

19 Nurses of the Cardiac Surgery Intensive Care Unit, 4 nurses of cardiac surgery operating room, 2 anesthetists, 2 students in anesthesia, attended the course in two editions.

From video shooting it was possible to analyze technical and non-technical skills in order to implement them during the second day of the course.

From the video analysis of the two days, the management of the cardiac arrest in CSICU has seen an increase in situational awareness in the recognition of cardiac arrest through the clinic and the technological equipment, multidisciplinary teamwork, a specific definition

of the roles of nurses, the establishment of a leadership, a decision making appropriate to the guidelines, an effective communication between eight actors in the simulation, positive communication feedback, absence of pharmacological errors from verbal prescription, progressive reduction of stress.

At the end of the two days it was possible to find out how the emergency clinical care time has been reduced. In particular during the first day the time from the recognition of cardiac arrest to the complete preparation of the bed for the reopening and the arrival of the cardiac surgeon was 11 minutes. During the second day the median time from the beginning of the cardiac arrest to chest re-opening and to the internal cardiac massage was six minutes, with the resternotomy occurred at the fifth minute, as stated in the guidelines.

Discussion

Cardiac arrest in cardiac surgery presents several intrinsic difficulties regarding the management of the crisis, the technology, the human resources, with a high level of care intensity.

The course has shown its validity in terms of reduction of timing, attribution of roles, decision making, objectives set by the instructors in the process of the first edition. The result is not achieved, but only started, with the purpose to an annual program for the maintenance of technical and non-technical skills useful for the certification of skills.

The CRM courses are still at the center of the debate, as "Are they effective?". One of the leading exponents of the CRM in health care shows how in the field of aviation it has been successful and how it can be reaped in health now, after about 20 years of work [3].

If we had to deal with the aeronautical world, the result of CRM is the absence of deaths in flight US 1549, landed on the Hudson river with 155 passengers on board.

However, in the health sector, several articles show the effectiveness in terms of reducing mortality through CRM courses that continuously certify technical and non-technical skills in health care [11] and CRM has proven to be an effective teaching method in the transmission of knowledge, in particular through the simulation [12-14].

Conclusion

In conclusion, the methodology of the crisis resource management turns out to be the effective method for the training and development of TS and NTS in complex environments and in multidisciplinary groups, thus maintaining the certification of skills.

Acknowledgments

Lorenzo Introzzi, MD, cardiac anesthesiologist in Cardiac Anesthesia, instructor and co-designer ALS course in CSICU - ASST Sette Laghi - University of Insubria - Varese - Italy.

Paolo Borsani, MD, Cardiac Surgeon in Cardiac Surgery, instructor and co-designer ALS course in CSICU - ASST Sette Laghi - University of Insubria - Varese - Italy.

Francesca Reato, MSN in Research and Professional Development and co-creator course ALS CSICU - DAPSS - ASST Sette Laghi - Didattic Coordinator of Master I level in Operating Room Nurses - University of Insubria - Varese - Italy.

Gabriella Somaini, RN, Emergency Service coordinator for the manikin lending - ASST Sette Laghi - University of Insubria - Varese - Italy.

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Volume 3 Issue 8 August 2019