Optimized Approach in Cardiocerebral Resuscitation

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Abstract

Cardiocerebral Resuscitation (CCR) is a new approach to the resuscitation of patients with out-of-hospital cardiac arrest (OHCA). The first major component of CCR is continuous chest compressions (also referred to as chest compression-only CPR or "hands-only CPR") advocated as part of CCR for all bystanders who witness a sudden collapse of presumed cardiac origin. The second component of CCR is a new ACLS treatment algorithm for Emergency Medical Services. This algorithm emphasizes uninterrupted chest compressions regardless of other ongoing assignments as part of the rescue effort. A third component has recently been added to CCR, namely aggressive post-resuscitation care. Cardiocerebral resuscitation has increased bystander participation and has improved survival rates in a number of communities. Now is the time for other communities to re-examine their own outcomes with cardiac arrest and consider joining those cities and communities that have doubled and even tripled their survival from OHCA.

Introduction

Cardiocerebral Resuscitation is a relatively new approach to the resuscitation of patients with out-of-hospital cardiac arrest (OHCA). By 2003, the local clinical experience in Arizona clearly indicated that chest compression (CC) interruption had a negative impact upon survival. Accordingly, in 2003, the Sarver Heart Center Resuscitation Research group of the University of Arizona, in cooperation with the Fire Department (FD), instituted a new comprehensive resuscitation program for OHCA. The FD was willing to institute the recommended changes because their municipal data base showed that in spite of periodic 'updates' and changes in accordance with Cardiopulmonary resuscitation (CPR) Guidelines, survival from OHCA had not significantly changed in the past 10 years. This new approach entitled, "Cardiocerebral Resuscitation" significantly modifies standard CPR to provide more consistent myocardial and central nervous system perfusion during cardiac arrest (CA).

Keywords

Resuscitation; oxygen inhalation therapy; desfibrillators/utilization; survival.

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The first major component of CCR is continuous chest compressions (CCC)[1]. Continuous chest compression CPR (also referred to as chest compression-only CPR or "hands-only CPR")[2] is advocated as part of CCR for all bystanders who witness a sudden collapse[3]. The rationale for CCC is based on the recognition that any CC interruption adversely affects blood flow to the brain and heart[3]. Assumptions of how quickly two mouth-to-mouth breaths could be delivered by lay persons were found to be erroneous by Assar and colleagues[4]. In this study of nearly 500 layperson single rescuers, the average time needed to deliver two mouth-to-mouth breaths was 16 seconds. This means that during a layperson's attempt at resuscitation no CC are being performed for a substantial amount of time, up to 50% of the resuscitation time in some cases. Such periods without CC results in marked compromise in blood flow to the heart and brain[5] and ultimately results in a decrease in survival. Continuous CC prevents these interruptions and provides better hemodynamic support resulting in better outcomes.

The second component of CCR is a new ACLS treatment algorithm for EMS[2,3]. This algorithm emphasizes uninterrupted CC, regardless of other ongoing assignments as part of the rescue effort.

Upon arrival EMS providers give 200 CC prior to obtaining a rhythm analysis; if ventricular fibrillation or tachycardia (VF/VT) is present, a single defibrillation shock is provided and additional 200 chest compressions are immediately performed. Three of these 200 compressions then analysis are performed before ETI is considered (Figure 1).

During the implementation of CCR in Arizona, ETI was delayed until at least 6 minutes. The current algorithm of CCR advocates passive oxygen insufflations as the initial airway management. This alternative to ETI was initiated in Wisconsin in 2004[6]. A hybrid approach was used in cities of Arizona in 2005 and in 46 FDs throughout Arizona in 2006-2007. This algorithm also delayed ETI, but allowed either bag valve mask ventilation or passive oxygen insufflation. In CCR passive oxygen insufflation is now preferred with a recent report showing improved survival when oxygen insufflation is utiltized[6].

A third component has been added to CCR, namely post-resuscitation care. This includes the use of therapeutic hypothermia and cardiac catheterization, with percutaneous coronary intervention (PCI), for resuscitated victims of OHCA. Randomized trials have shown the value of hypothermia in improving outcome post resuscitation[7]. Recent data has found that early PCI also improves outcomes among those resuscitated from OHCA[8]. Analysis of the nearly 1,000

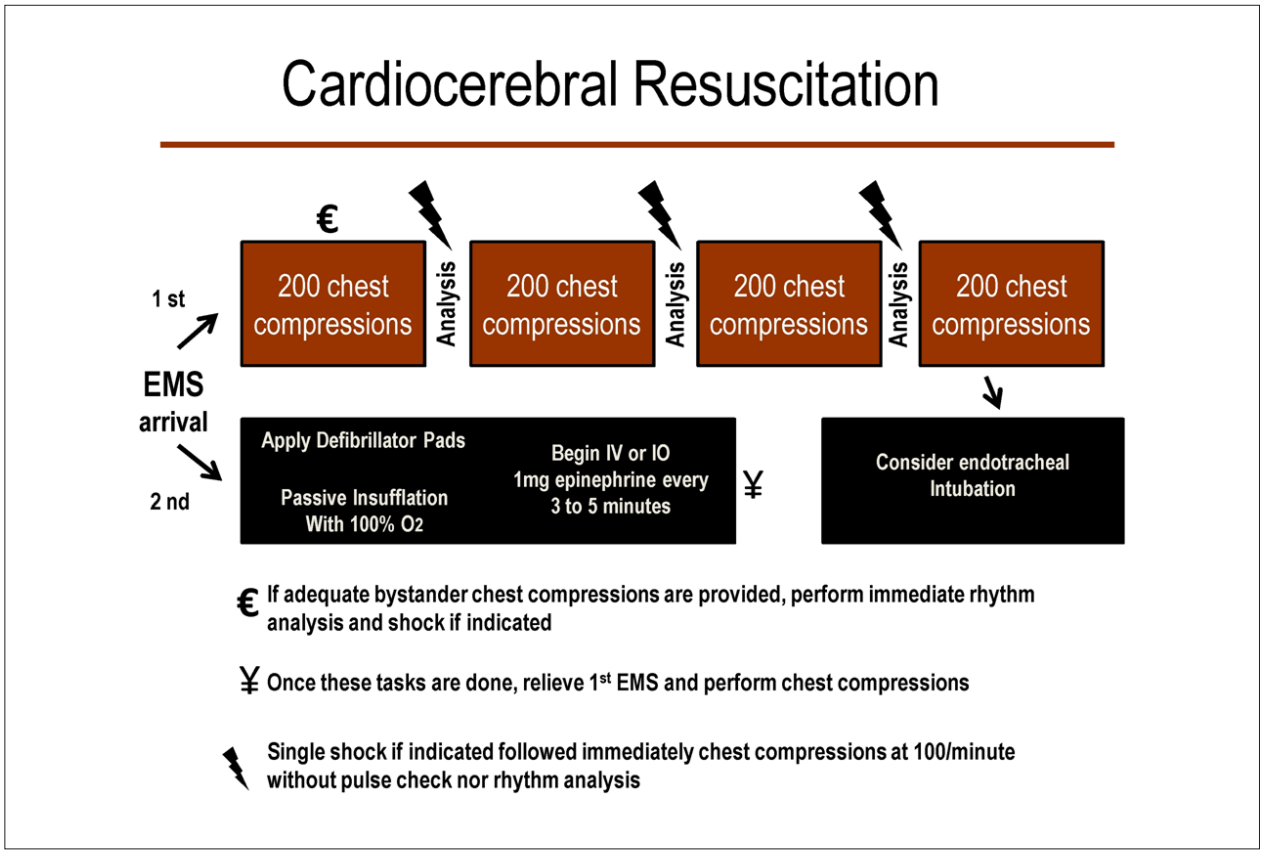

Figure 1 - Cardiocerebral Resuscitation Algorithm. Begin with 200 CCC. The second rescuer applies both defibrillator pads and continuous oxygen insufflations, placing an oral /pharyngeal airway and then a non-rebreather mask with high-flow oxygen (10-15 l/min). After 200 CCC, a rhythm analysis is done. Shockable rhythms are treated with a single shock and then 200 more CC are immediately administered. During the first or second cycle of 200 compressions, either an IO or IV line can be secured by the 2nd or 3rd rescuer and epinephrine 1 mg should be administered. After finishing the 2nd round of 200 CC, an additional rhythm analysis is performed. If a shockable rhythm is detected apply again a single defibrillation shock then an additional 200 CCC. If patient persists with resuscitation consider ETI.

patients so treated post resuscitation suggests that a 65% survival rate can be achieved, with 80% of such survivors being neurologically-intact[8].

Cardiocerebral resuscitation improves survival

Dr. Kellum and colleagues instituted CCR in Wisconsin in 2004. Their historical control period of the preceding 3 years when Guidelines 2000 were operative produced a neurologically-intact survival rate at hospital discharge rate of 15%. During the first three years, neurologically-intact survival was 40% (including the one patient submitted to hypothermia)[6].

The national and international guidelines for CPR were updated in 2005 and 2010 and included some of the approaches advocated by CCR. The AHA issued a science advisory statement in 2008 sanctioning the use of "Hands-Only" (Compression-Only) CPR for bystanders in adult CA[4].

Cardiocerebral resuscitation increases law enforcement officer bystander CPR

Cardiocerebral resuscitation recommends CCC for all bystanders. It was anticipated that this recommendation would increase the incidence of lay bystander CPR. Dr. Kellum has observed in Wisconsin, that following the introduction of CCC, the incidence of law enforcement officer bystander CPR increased. Knowing that they would not be required to perform mouth-to-mouth ventilations, law officers appeared more likely to initiate bystander CPR in patients with CA.

Cardiocerebral resuscitation advocates either immediate or delayed defibrillation, based on the 3-phase time-sensitive model of VF[9]. Immediate defibrillation is recommended during the electrical phase[3]. However, EMS personnel in most cities arrive in the circulatory phase of VF arrest[1]. During the circulatory phase of VF, the fibrillating myocardium has used up much of its energy stores, and CC that perfuse the heart are advocated, not only prior to, but also immediately after a single defibrillator shock. Cardiocerebral Resuscitation advocates 200 chest compressions (100 per minute) without assisted ventilation prior to defibrillation shock[1,4].

Equally important in the CCR protocol is the provision of 200 CC initiated immediately after a single shock without rhythm analysis or pulse check[1,4].

Since our group and others found that, during the circulatory phase of VF arrest, any interruption or delay in CC was deleterious, ETI (which always interrupts chest compressions to some degree) is *initially* prohibited by CCR[1,4,5].

To prevent the common mistake by EMS of hyperventilating CA, the current CCR approach to ventilation is passive oxygen insufflation. This consists of first inserting an oral pharyngeal airway then placing a non-rebreather mask with high flow (10-15 liters per min) oxygen[4]. Intubation is indicated after 3 cycles of chest compressions (Figure 1).

The recently added third component of CCR, namely aggressive post resuscitation care that includes therapeutic hypothermia and early PCI improved hospital discharge with favorable neurological outcome from 26% to 56% ($p<0.001$)[8]. The Arizona Department of Health Services Bureau of EMSs and Trauma Systems, have established "Cardiac Arrest Centers" hospitals, much like the present "Trauma Center" designations. These hospitals must be able and willing to provide therapeutic hypothermia and urgent PCI for resuscitated victims of OHCA.

Role of cardiocerebral resuscitation in unwitnessed, prolonged or asystolic cardiac arrest

There has been concern that CCR would adversely affect patients with un-witnessed VF or especially non-VF cardiac arrest rhythms, such as asystole or PEA. The survival-to-hospital discharge data from the metropolitan Phoenix area shows an increase in survival to hospital discharge from 1.8% (4/218) prior to CCR to 5.4% (36/668) after instituting CCR [OR of 3.0; 1.1-8.6]. Further analysis of this population of non-selected OHCA victims showed that 2 of the 4 survivors (50.0%) in the pre-period had unwitnessed VF or non-VF, while 13 of the 36 survivors (36.1%) had similar rhythms from the post- CCR study period. This translates into a survival rate for the unwitnessed VF or non-VF of 2/218 (0.9%) pre-CCR and 13/668 (1.9%) post CCR. Chi-square calculates to 1.045, indicating an insignificant *p* value of 0.3. Hence, no significant difference in outcome is found, though survival to discharge was doubled (not decreased) in the post CCR era[6] (compared with historical control survival from OHCA). These data suggest CCR is not detrimental in patients whose cardiac arrest is not from witnessed VF CA.

Conclusions

Cardiocerebral resuscitation has increased bystander participation in resuscitation efforts, provides more blood flow to the heart and brain during the crucial early minutes of CA, and has improved long-term survival in a number of communities. Now is the time for other communities to re-examine their own outcomes with cardiac arrest and consider joining those cities and communities that have doubled and even tripled their survival from OHCA[10].

Potential Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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Study Association

This study is not associated with any post-graduation program.

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