Learning Objectives

At the conclusion of this presentation the attendee should be able:

1. To articulate the basic principles of cardiocerebral resuscitation (CCR) and its application to basic life support.
2. To describe the evolution of the science behind CCR.
3. To understand the three component pathophysiologic model of ventricular fibrillation and its clinical application to CCR as the new basic life support (BLS).
4. To describe current controversies and areas for further exploration in CCR.

Introduction

The genesis of cardiocerebral resuscitation originated from a series of swine animal model experiments performed at the University of Arizona in the 1990’s leading to implementation of a new model of resuscitation that was clinically trialed in Tucson, Arizona in 2003 and rural Wisconsin in 2004. This new model for resuscitation emphasized the circulation component of the traditional A-B-C’s by using chest compressions before defibrillation, delaying airway management, minimizing initial pre-compression pulse checks in the unconscious patient, and a “push fast” concept; both groups reported a significant increase in neurologically intact survivors of 18% and 40%, respectively.1,2

Rationale for CCR Paradigm

In order to explain the new philosophical approach to the basic life support component of resuscitation, a three tiered model of ventricular fibrillation after myocardial infarction, which was published about one decade ago, helps us understand the rationale behind CCR.3

Electrical Phase

The first phase is the electrical phase which lasts for about 4 minutes. During this phase, defibrillation is an effective treatment to restore myocardial tissue back to a more electrically organized and mechanically effective rhythm. Unfortunately, since this phase only lasts four minutes, defibrillator use is only effective for patients who have immediate access to this therapy. This would include such venues as airplanes or casinos where the “event” leading to a subsequently unconscious patient is “witnessed” due to the “public” aspect of the event.
Theoretically, one might also include those individuals in a monitored healthcare setting where such an “event” would also be immediately recognized.

The widely understood effective nature of early defibrillation in this subset of patients served as the basis of the long-standing recommendation by resuscitation training groups such as the American Red Cross (ARC) and American Heart Association (AHA) to incorporate defibrillation as an essential first-line strategy in the “C” component of the ABC’s of resuscitation. This originally included the idea of stacked shocks which later became a single shock in the 2005 AHA Cardiopulmonary Resuscitation Guidelines.

**Circulatory Phase**

During the second phase of ventricular fibrillation (VF), the circulatory phase lasting from 4-10 minutes, the most important goal is to restore perfusion to the myocardium and to the brain. The oxygen deprived or hypoxic myocardium is refractory to defibrillation, and defibrillation during this stage may even be harmful to patient outcome. Once defibrillation occurs, immediate resumption of external chest compressions is essential as ventricular fibrillation treated with defibrillation in this phase often becomes asystole or pulseless electrical activity (PEA), and myocardial perfusion is essential to facilitate transition of these rhythms to organized electrical activity. If the myocardium is not perfused, PEA will often degenerate to ventricular fibrillation or asystole.

It can be easily surmised that rescuers rarely arrive during the first 4 minutes of a victim’s cardiac arrest except in those aforementioned, rare “public” scenarios. Instead, it is much more common for rescuers to arrive in this 4-10 minute time window, provided there is early recognition and an efficient EMS activation and response. Thus, the desire to optimize the probability of successful defibrillation while preventing degeneration of more electrically organized rhythms to ventricular fibrillation (coupled with a rescuer arrival time of between 4-10 minutes) led the developers of the CCR paradigm to the recommendation of instituting external chest compressions prior to and immediately after defibrillation. Thus, the old mantra of “shock first” becomes “shock second.”

**Metabolic Phase**

In the third phase of ventricular fibrillation (after 10 minutes), there is currently little that can be done to resuscitate the patient which explains the dismal survival in this group of patients who are recognized at this stage of the VF event. Hypothermia is, perhaps, the most successful known therapy at this juncture, but application to the patient in an expeditious manner is virtually impossible.

**The A-B Heresy of the A-B-C’s**

As anesthesiologists we are indoctrinated with a philosophy that the principles of airway maintenance and breathing are essential initial components of resuscitation. While this may be true in certain patient populations (i.e. pediatric cardiac arrest), its lack of utility in adult cardiac arrest has been described for
over two decades with scientific information originating in a porcine model of cardiac arrest that found no difference in swine survival using a chest compression alone model compared to a chest compressions plus ventilation model.⁶

This information has resulted in the recommendation of “Hands-only CPR” for the lay rescuer which can now be administered via 911 telephone instructions to callers for potential cardiac arrest victims. The thought that traditional cardiopulmonary resuscitation (CPR) can be administered in an effective, life-saving manner by the untrained lay rescuer certainly contradicts the years of information promulgated by the American Heart Association (AHA) and American Red Cross (ARC) which emphasized that training in BLS is essential for rescuers. Additionally, this new philosophical stance has also allowed the application of “bystander CPR” without mouth-to-mouth ventilation for witnessed sudden collapse of victims. This “bystander CPR” is not only likely to occur more frequently, but it also improves patient survival by allowing defibrillation of circulatory phase myocardial tissue when emergency medical services personnel arrive at the scene.⁷,⁸

Additionally, the recent 2010 AHA guidelines also stress the importance of not interrupting compressions for advanced airway placement and delaying tracheal intubation until the patient fails to respond to initial resuscitation attempts or demonstrates return of cardiovascular perfusion. Once the advanced airway is placed, ventilation is to occur only once every 6 to 8 seconds (8-10 breaths per minute) in order to limit increases in intrathoracic pressure which will result in diminished venous return and decreased cardiac output.

**CCR Beyond BLS**

**Hypothermia**

The use of mild therapeutic hypothermia to 32-34°C has been shown to improve both post-cardiac arrest survival and neurologic outcome based on clinical trials in both Europe and Australia.⁹,¹⁰ Thus, its prompt application to victims of cardiac arrest due to ventricular fibrillation or pulseless ventricular tachycardia is now recommended. This has led many institutions to develop therapeutic critical care medicine protocols for patient cooling while minimizing cardiovascular stress and patient discomfort. As newer devices have been developed, the ability to induce rapid cooling, sustained hypothermia and easier rewarming have greatly improved.

**Tiered Response Systems**

The use of AED’s and the institution of “first responder” defibrillation has allowed nursing and ancillary healthcare staff who work in less specialized care units to independently perform defibrillation in a safe, controlled manner irrespective of whether the victim is in the intensive care unit or an outpatient clinic. This prevents the delays that might be incurred by limiting resuscitation therapy to traditional hospital “code teams.”¹¹ The literature in this area is limited but such models do currently exist as there is a shift of reliance and accountability on the “first responder” in health care organizations. Clearly, as many academic and community health care organizations grow in size, the traditional models for resuscitation response must be re-engineered as the “run faster” logic is short sighted and a predisposition for failure.
Summary
The current concept of CCR emphasizes the importance of approaching adult victims of sudden cardiac arrest in a C-A-B prioritization. Additionally, restoration of spontaneous circulation is dependent on either early defibrillation or defibrillation of an “optimized” myocardium. The application of BLS to these victims must greatly minimize interruptions in external chest compression, and the old adage of “airway first” is no longer applicable to these victims. Finally, the use of therapeutic post-cardiac arrest hypothermia and targeted, tiered response systems may allow even greater improvements in patient survival when using CCR.