

# Hands-only CPR: a literature review on the benefits of chest compression-only CPR for out-of-hospital cardiac arrest

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## Abstract

Cardiac arrest remains a common cause for emergency medical attention every year. In spite of efficient emergency-medical-services management, a very low percentage of people who suffers from one of these events survive neurologically intact. If cardiopulmonary resuscitation (CPR) is performed shortly after the cardiac event, it can increase the survival rate by at least three fold. However, for every minute that goes by without CPR after a sudden cardiac arrest the survival rate decreases by 7 to 10%. Unfortunately, only 20-30%

of these sudden-cardiac-death episodes receive initial CPR by bystanders.

If “classic” CPR is modified to a technique in which ventilations are spared and only chest compressions are administered, the number of bystander resuscitations will raise and with that the chances of survival. On October 2010 the new basic life support guidelines officially encouraged the use of hands-only CPR for the untrained lay-rescuer. This systematic review analyses the pros and cons of such technique.

**Key words:** CPR, CCR, hands-only CPR, compression-only CPR, cardiocerebral resuscitation, cardiopulmonary resuscitation.

## Introduction

Every year in the United States the emergency medical services manage over 300,000 out-of-hospital cardiac arrests. (1,2) Unfortunately, less than eight percent of people who suffer from one of these events will survive neurologically intact. (3) Therefore, sudden cardiac death remains one of the major health issues of modern society. (4) Moreover, millions of people are at high risk for a lethal cardiac event

and are not even aware of that fact. (3) Whether the victims of sudden cardiac arrest are apparently healthy, or if they have known predisposing diseases is irrelevant; the fact is no one is really prepared for this unfortunate event. (3,5) As a sudden event, most of cases occur away from easy access to the medical services and the primary care relies on bystander action. (5,6)

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One way to address this issue is to simplify the resuscitation protocols. One such simplification modifies the “classic” cardiopulmonary resuscitation (CPR) in which chest compressions and ventilations alternate at a rate of 30:2, to a technique in which ventilations are spared and only chest compressions are administered instead. (7,8)

## Historical background

The very first attempts to resuscitate people date back

millennia. (9,10) Several methods and techniques were employed at the time and some have evolved throughout history. (11) From rolling people over a barrel, riding horses on their abdomen and placing them upside down to the top-of-the-edge technologies (i.e. ventilators and compression devices), resuscitation from death is no longer a rarity. (12-14)

The first documented successful resuscitation of human using closed chest compressions is attributed to Friedrich Maass in 1891. (15,16) Unfortunately, due to the lack of understanding of the pathophysiology of cardiac arrest, this technique was abandoned for many decades. (15) At that time, direct cardiac massage with thoracotomy was one alternate accepted method for resuscitation. (17,18)

It was William Kouwenhoven and collaborators who in 1960 published a complete description of “closed-chest-cardiac-massage” techniques, as well as the use of defibrillation. (19) By 1970, the importance of public knowledge of these techniques was finally appreciated. (20) Several campaigns promoted teaching the lay population and the telephone assisted instruction by the “911” answering service was also initiated. (10) This “external chest compression” technique has remained as the preferred modality to provide resuscitation since 1960. (10,12)

Over the past few decades, the basic life support protocols have constantly changing, searching for the perfect ratio between compressions and ventilations in order to optimize the outcomes. (11,21-23) In 2005, the International Liaison Committee on Resuscitation (ILCOR) and the American Heart Association (AHA) set the ideal protocol to be 30 compressions for every 2 ventilations as the standard care. (22) Since then, the major importance of compressions over ventilations has been suggested by many authors. (24-26) Indeed, the possibility of eliminating mouth-to-mouth ventilations was already suggested in the 2006 edition of the ACLS manual by the American Heart Association. (27)

On October 18, 2010 the new basic life support guidelines changed the universally known Airway-Breathing-Circulation (A-B-C) sequence for a modified version now called C-A-B where the chest compressions are prioritized and the ventilations become secondary. (28) Additionally, the hands-only CPR technique was officially endorsed

by the American Heart Association. They recommended “encouraging hands-only (chest compression only) CPR (i.e., continuous chest compression over the middle of the chest) for the untrained lay-rescuer”. (21)

## **Epidemiology**

As noted above, every day in the United States around 1000 people will suffer sudden cardiac death. (1,3,10) If CPR is performed shortly after the cardiac event, it can increase the survival rate by three fold. (3,5,29) However, for every minute that goes by without CPR after a sudden cardiac arrest the survival rate decreases by 7 to 10%. (30,31)

What is most interesting is that everyone has seen at least once CPR being performed (either on real life, television or movies). Eighty percent of the population alleges they know what to do in case of sudden cardiac arrest and over 50% have some knowledge on CPR. (1) Unfortunately, only 20-30% of these sudden cardiac death episodes receive initial CPR by a bystanders and most of these events occur away from any medical setting. (32) Moreover, most people don't have the sufficient knowledge and training on this subject and are afraid of causing more harm. (33,34) In addition, and probably the most common situation, they don't feel comfortable by giving mouth-to-mouth ventilation. (32,33)

Despite the easier access and use of Automatic External Defibrillators (AED) survival rates haven't improved; only 20-30% of cardiac arrests are due to ventricular fibrillation. (35,36) The only way to increase the chances of return of spontaneous circulation (ROSC) and survival is maintenance of blood flow to vital organs. (37) This can only be achieved by increasing bystander resuscitation. (22,33,38)

## **Compression-only cardiocerebral resuscitation**

Chest compression resuscitation (CCR) or hands-only CPR is the method by which artificial blood flow and resuscitation is given by applying continuous external chest compressions without the interruption to provide ventilations. (21,39) The efficacy of this method has been evaluated by different observational and randomized studies. (34,40-45) Recently,

most of these studies have concluded that there is no major difference in outcome between standard CPR and CCR. (41,42,46-48) The survival rates are very similar regardless which method is used favoring the compression-only method with a trend to increased survival ranging from 1-2% up to 8% above conventional CPR. (41,47) Some authors have postulated that the neurological outcome has improved with CCR (7% higher than conventional CPR). (47)

Part of the controversy in using CCR arises from animal models that show that chest compressions by itself are not enough to generate enough ventilation into the lungs to provide appropriate oxygenation. (32,49,50) The latter has been refuted in some studies which have proven that even under the worst circumstances, (i.e. total airway occlusion), CCR is as good as standard compressions plus ventilations. (51) Furthermore, there is increasing data showing improved survival and neurologic outcome with CCR. (24,52)

During conventional CPR, the importance of continuous compressions with minimal pause for ventilations (30:2 ratio) has been prioritized. (22) In theory, increasing the time of effective compressions and minimizing the interruption time to less than 5 seconds is the goal. (22) Unfortunately, in reality, most rescuers take up to 16 seconds to administer the 2 “one-second” ventilations. (41) In addition, the different skills needed to provide conventional CPR require recurrent training for most people, if they are not in constant practice, decreasing the ability to provide effective resuscitation. (53) In the prehospital setting, another point that favors CCR is the fact that it takes longer to provide over-the-telephone instructions for conventional CPR, which will delay resuscitation by laypersons. (42)

### **Why does it work?**

Regardless of the primary cause of sudden cardiac death, the cessation of heart contraction and the consequent decrease in blood pressure and organ perfusion rapidly ensues. (54,55) This is followed by ischemia of the tissues and death. (10) The primary role of CPR is to maintain an artificial blood flow, while attempting to reestablish spontaneous circulation. (56,57)

There are two main theories as to the mechanism of blood flow during CPR (**Figure 1**). (58) The thoracic pump which emphasizes changes in intrathoracic pressures, and the cardiac pump theory where the heart acts as a pump while being squeezed between the spine and the sternum. (59) One major issue with conventional CPR is that every time chest compressions are stopped in order to provide ventilations, the blood pressure drops and, the victim requires several compressions before reaching the necessary levels to perfuse vital organs. (24,60,61)

Some authors have suggested that compression-only is not sufficient to provide the oxygenation necessary to reach normal levels. (49,62) Others, on the contrary, have argued that it's not necessary to reach those “high oxygen levels” because the oxygen consumption during resuscitation is diminished. (49,63)

For years, well-established CPR research groups have concluded that during the first 12 minutes, low oxygen levels and even “just gasping” may be enough for successful resuscitation. (63,64) Recent evidence on CCR suggests that if this technique is performed for short periods of time it will be enough to maintain adequate oxygenation to the vital tissues without causing neurological impairment. (37,64) Steen-Hansen recently reported a case where chest compression-only CPR was given for 26 minutes before EMS assistance and the victim recovered fully. (51,65) However, recent data show that cardiac arrests that require resuscitation maneuvers for prolonged periods of time, benefit more from conventional CPR with chest compressions and ventilations. (66)

Another important point in favor of CCR is that there is proof that in some cases CPR can be more harmful than CCR; especially in untrained people. (37) One of the major risks associated with CPR is gastric insufflation and the consequent gastric content regurgitation and aspiration. (60) It has also been demonstrated that the higher CO<sub>2</sub> concentrations provided by mouth-to-mouth ventilation can have adverse effects, (i.e. intracellular acidosis, myocardial depression), thus, diminishing the probabilities of successful resuscitation. (60,67,68) As mentioned before it has also been proved that it takes too long for inexperienced providers to give mouth-to-mouth ventilations, which results

in interruption of the blood flow to the heart and brain. This causes adverse outcomes in spite of the resuscitation efforts. (42,69)

**The technique for CCR**

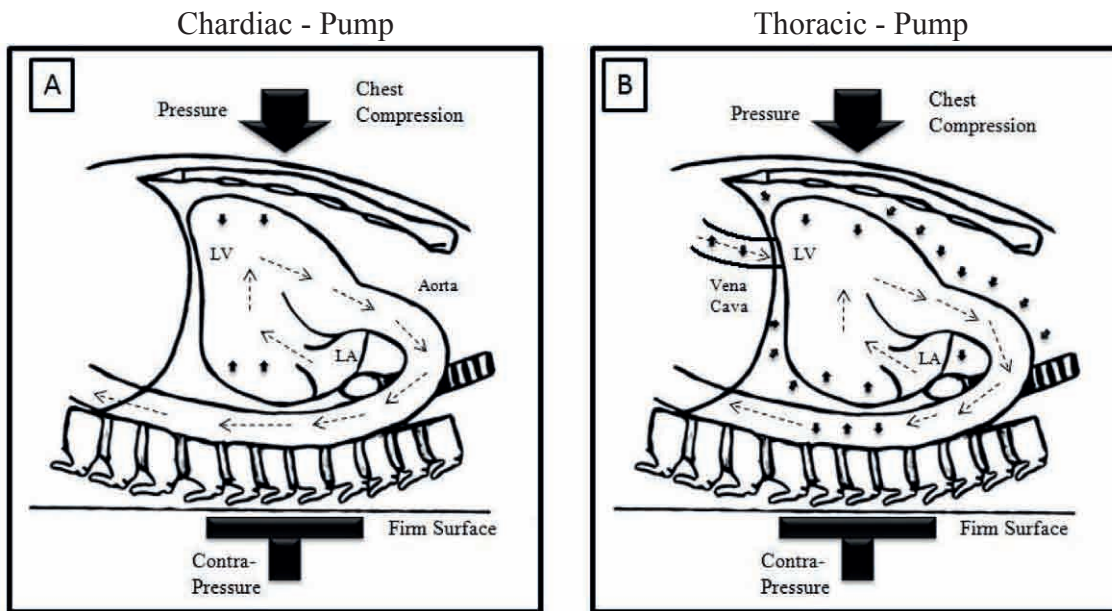
Although the guidelines haven't created a complete protocol for the CCR, some authors and several informational bulletins have described the technique in order to teach the general public. (21,39,70) First it's important to place the victim in a supine position on a surface as firm as possible. Then, the provider is to be positioned beside the patient on a kneeling posture and place his hands overlapping one another on the middle of the victim's chest. The rescuer is to provide direct and continuous compressions using the heel of his hand. The chest compressions should be performed a rate of 100 compressions per minute with a depth of at least two inches caring to allow for complete recoil after every compression.

It is important to minimize exhaustion that can lead to inadequate resuscitation. Therefore, it's recommended to switch rescuers every two minutes when possible. This technique should be continued like this until professional help arrives. (21,39,71)

**Conclusions**

It is clear that CCR has better neurological outcomes than no resuscitation efforts, and this technique is equivalent or even better than conventional CPR. Compression-only resuscitation is easier and lay people are more likely to perform it. Hands-only CPR is a good alternative for untrained people who find themselves in an emergency situation that requires cardiac resuscitation. This will increase the amount of bystander CPR and hence the possibility of better outcomes and survival rates.

**Figure 1.** Two main theories as to the mechanism of blood flow during CPR



Legend: Panel A displays the cardiac-pump blood flow mechanism in which the heart is “squeezed” between the sternum and the vertebral spine during the chest compression. This causes a rise in the cardiac pressure resulting in the movement of blood from the auricles to the ventricles and finally to the large vessels. Panel B shows the thoracic-pump theory in which an equal increase in central venous, right atrial, pulmonary circulation, aortic, esophageal, and pleural space pressures, can be observed. A gradient with the peripheral venous system occurs leading to systemic blood flow.

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