Cardiopulmonary resuscitation (CPR) is an emergency procedure which is performed in an effort to manually preserve intact brain function until further measures are taken to restore spontaneous blood circulation and breathing in a person in cardiac arrest. It is indicated in those who are unresponsive with no breathing or abnormal breathing, for example agonal respirations. It may be performed both in and outside of a hospital.

CPR involves chest compressions at least 5 cm deep and at a rate of at least 100 per minute in an effort to create artificial circulation by manually pumping blood through the heart. In addition, the rescuer may provide breaths by either exhaling into the subject's mouth or utilizing a device that pushes air into the subject's lungs. This process of externally providing ventilation is termed artificial respiration. Current recommendations place emphasis on high-quality chest compressions over artificial respiration; a simplified CPR method involving chest compressions only is recommended for untrained rescuers.

CPR alone is unlikely to restart the heart; its main purpose is to restore partial flow of oxygenated blood to the brain and heart. The objective is to delay tissue death and to extend the brief window of opportunity for a successful resuscitation without permanent brain damage. Administration of an electric shock to the subject's heart, termed defibrillation, is usually needed in order to restore a viable or "perfusing" heart rhythm. Defibrillation is only effective for certain heart rhythms, namely ventricular fibrillation or pulseless ventricular tachycardia, rather than asystole or pulseless electrical activity. CPR may succeed in inducing a heart rhythm which maybe shockable. CPR is generally continued until the subject regains return of spontaneous circulation (ROSC) or is declared dead.

### Contents

- 1 Medical uses
- 2 Methods
  - 2.1 Standard
  - 2.2 Compression only
  - 2.3 In pregnancy
Medical uses

CPR is indicated for any person who is unresponsive with no breathing, or who is only breathing in occasional agonal gasps, as it is most likely that they are in cardiac arrest.[1]:S643 If a person still has a pulse, but is not breathing (respiratory arrest), artificial respirations may be more appropriate, but due to the difficulty people have in accurately assessing the presence or absence of a pulse, CPR guidelines recommend that lay persons should not be instructed to check the pulse, while giving health care professionals the option to check a pulse.[2] In those with cardiac arrest due to trauma CPR is considered futile but still recommended.[3]

Methods

In 2010, the American Heart Association and International Liaison Committee on Resuscitation updated their CPR guidelines.[1]:S640[4] The importance of high quality CPR (sufficient rate and depth without excessively ventilating) was emphasized.[1]:S640 The order of interventions was changed for all age groups except newborns from airway, breathing, chest compressions (ABC) to chest compressions, airway, breathing (CAB).[1]:S642 An exception to this recommendation is for those who are believed to be in a respiratory arrest (drowning, etc.).[1]:S642

Standard

A universal compression to ventilation ratio of 30:2 is recommended for adult and in children and infant if
only a single rescuer is present.[5]:8 If at least 2 rescuers are present a ratio of 15:2 is preferred in children and infants.[5]:8 In newborns a rate of 3:1 is recommended unless a cardiac cause is known in which case a 15:2 ratio is reasonable.[1]:S647 If an advanced airway such as an endotracheal tube or laryngeal mask airway is in place delivery of respirations should occur without pauses in compressions at a rate of 8-10 per minute.[6] The recommended order of interventions is chest compressions, airway, breathing or CAB in most situations.[1]:S642 With a compression rate of at least 100 per minute in all groups.[5]:8 Recommended compression depth in adults and children is about 5 cm (2 inches) and in infants it is 4 cm (1.5 inches).[5]:8 As of 2010 the Resuscitation Council (UK) still recommends ABC for children.[7] As it can be difficult to determine the presence or absence of a pulse the pulse check has been removed for lay providers and should not be performed for more than 10 seconds by health care providers.[5]:8 In adults rescuers should use two hands for the chest compressions, while in children they should use one, and with infants two fingers (index and middle fingers).[8]

**Compression only**

Compression only (hands-only or cardiocerebral resuscitation) CPR is a technique that involves chest compressions without artificial respiration.[1]:S643 It is recommended as the method of choice for the untrained rescuer or those who are not proficient as it is easier to perform and instructions are easier to give over the phone.[1]:S643[5]:8[9] In adults with out-of-hospital cardiac arrest, compression-only CPR by the lay public has a higher success rate than standard CPR.[9] The exceptions are cases of drownings, drug overdose, and arrest in children. Children who receive compression only CPR have the same outcomes as those who received no CPR.[1]:S646 The method of delivering chest compressions remains the same, as does the rate (at least 100 per minute). It is hoped that the use of compression only delivery will increase the chances of the lay public delivering CPR.[10] For those with non cardiac arrest and people less than 20 years of age standard CPR is superior to compression only CPR.[11][12]

**In pregnancy**

During pregnancy when a women is lying on her back the uterus may compress the inferior vena cava and thus decrease venous return.[3] It is recommended for this reason that the uterus be pushed to the persons left and if this is not effective either role the person 30°s or consider emergency cesarean section.[3]

**Other**

Interposed abdominal compressions may be beneficial in the in hospital environment.[13] There is however no evidence of benefit pre hospital or in children.[13] Internal cardiac massage is manual squeezing of the heart carried out through a surgical incision into the chest cavity. This may be carried out if the chest is already open for cardiac surgery.

**Effectiveness**

Used alone, CPR will result in few complete recoveries, and those who do survive often develop

<table>
<thead>
<tr>
<th>Type of Arrest</th>
<th>ROSC</th>
<th>Survival</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>48%</td>
<td>22%</td>
<td>[14]</td>
</tr>
</tbody>
</table>
serious complications. Estimates vary, but many organizations stress that CPR does not "bring anyone back," it simply preserves the body for defibrillation and advanced life support.[16]
However, in the case of "non-shockable" rhythms such as Pulseless Electrical Activity (PEA), defibrillation is not indicated, and the importance of CPR rises. On average, only 5–10% of people who receive CPR survive.[18] The purpose of CPR is not to "start" the heart, but rather to circulate oxygenated blood, and keep the brain alive until advanced care (especially defibrillation) can be initiated. As many of these patients may have a pulse that is impalpable by the layperson rescuer, the current consensus is to perform CPR on a patient who is not breathing.

Studies have shown the importance of immediate CPR followed by defibrillation within 3–5 minutes of sudden VF cardiac arrest improve survival. In cities such as Seattle where CPR training is widespread and defibrillation by EMS personnel follows quickly, the survival rate is about 30 percent. In cities such as New York, without those advantages, the survival rate is only 1–2 percent.[17]

In most cases, there is a higher proportion of patients who achieve a Return of Spontaneous Circulation (ROSC), where their heart starts to beat on its own again, than ultimately survive to be discharged from hospital (see table below). This is due to medical staff either being ultimately unable to address the cause of the arrhythmia or cardiac arrest, or in some instances due to other co-morbidities, due to the patient being gravely ill in more than one way.

Compression-only CPR is less effective in children than in adults, as cardiac arrest in children is more likely to have a non-cardiac cause. In a 2010 prospective study of cardiac arrest in children (age 1–17), for arrests with a non-cardiac cause provision by bystanders of conventional CPR with rescue breathing yielded a favorable neurological outcome at one month more often that did compression-only CPR (OR 5.54; 95% confidence interval 2.52–16.99). For arrests with a cardiac cause in this cohort, there was no difference between the two techniques (OR 1.20; 95% confidence interval 0.55–2.66).[19] This is consistent with American Heart Association guidelines for parents.[20]

### Pathophysiology

CPR is used on people in cardiac arrest in order to oxygenate the blood and maintain a cardiac output to keep vital organs alive. Blood circulation and oxygenation are required to transport oxygen to the tissues. The brain may sustain damage after blood flow has been stopped for about four minutes and irreversible damage after about seven minutes.[21][22][23][24][25] Typically if blood flow ceases for one to two hours, the cells of the body die. Because of that CPR is generally only effective if performed within seven minutes of the stoppage of blood flow.[26] The heart also rapidly loses the ability to maintain a normal rhythm. Low body temperatures as sometimes seen in near-drownings prolong the time the brain survives. Following cardiac arrest, effective CPR enables enough oxygen to reach the brain to delay brain death, and allows the heart to remain responsive to defibrillation attempts.

### Adjunct devices
While several adjunctive devices are available none other than defibrillation as of 2010 have consistently been found to be better than standard CPR for out of hospital cardiac arrest. These devices can be split into three broad groups - timing devices, those that assist the rescuer to achieve the correct technique, especially depth and speed of compressions, and those which take over the process completely.

**Timing devices**

They can feature a metronome (an item carried by many ambulance crews) in order to assist the rescuer in getting the correct rate. Some units can also give timing reminders for performing compressions, breathing and changing operators.

**Manual assist devices**

Mechanical devices have not been found to have greater benefit than harm and thus are not currently recommended for widespread use.

Audible and visual prompting may improve the quality of CPR and prevent the decrease of compression rate and depth that naturally occurs with fatigue, and to address this potential improvement, a number of devices have been developed to help improve CPR technique.

These items can be devices to placed on top of the chest, with the rescuer's hands going over the device, and a display or audio feedback giving information on depth, force or rate, or in a wearable format such as a glove. Several published evaluations show that these devices can improve the performance of chest compressions.

As well as use during actual CPR on a cardiac arrest victim, which relies on the rescuer carrying the device with them, these devices can also be used as part of training programs to improve basic skills in performing correct chest compressions.

**Automatic devices**

There are also some automated devices available which take over the chest compressions for the rescuer. These have several advantages: they allow rescuers to focus on performing other interventions; they do not fatigue and begin to perform less effective compressions, as humans do; and they are able to perform effective compressions in limited-space environments such as air ambulances, where manual compressions are difficult. These devices use either pneumatic (high-pressure gas) or electrical power sources to drive a compressing pad on to the chest of the patient. One such device, known as the LUCAS, was developed at the University Hospital of Lund, is powered by the compressed oxygen supplies already standard in ambulances and hospitals, and has undergone numerous clinical trials, showing a marked improvement in coronary perfusion pressure and return of spontaneous circulation.

Another system called the AutoPulse is electrically powered and uses a large band around the patient's chest which contracts in rhythm in order to deliver chest compressions. This is also backed by clinical studies showing increased successful return of spontaneous circulation.

**Prevalence**
**Chance of receiving CPR**

Various studies suggest that in out-of-home cardiac arrest, bystanders, lay persons or family members attempt CPR in between 14%\cite{44} and 45%\cite{45} of the time, with a median of 32%. This indicates that around a third of out-of-home arrests have a CPR attempt made on them. However, the effectiveness of this CPR is variable, and the studies suggest only around half of bystander CPR is performed correctly\cite{46}\cite{47}.

There is a clear correlation between age and the chance of CPR being commenced, with younger people being far more likely to have CPR attempted on them prior to the arrival of emergency medical services\cite{44}\cite{48}. It was also found that CPR was more commonly given by a bystander in public than when an arrest occurred in the patient's home, although health care professionals are responsible for more than half of out-of-hospital resuscitation attempts\cite{45}. This is supported by further research, which suggests that people with no connection to the victim are more likely to perform CPR than a member of their family\cite{49}. This is likely because of the shock experienced by finding a family member in need of CPR; it is easier to remain calm and think clearly when the person in need of CPR is a complete stranger, as in this case one will not be as frightened.

There is also a correlation between the cause of arrest and the likelihood of bystander CPR being initiated. Lay persons are most likely to give CPR to younger cardiac arrest victims in a public place when it has a medical cause; victims in arrest from trauma, exsanguination or intoxication are less likely to receive CPR\cite{49}.

Finally, it has been claimed that there is a higher chance of CPR being performed if the bystander is told to only perform the chest compression element of the resuscitation\cite{10}.

**Chance of receiving CPR in time**

CPR is only likely to be effective if commenced within 6 minutes after the blood flow stops\cite{50} because permanent brain cell damage occurs when fresh blood infuses the cells after that time, since the cells of the brain become dormant in as little as 4–6 minutes in an oxygen deprived environment and the cells are unable to survive the reintroduction of oxygen in a traditional resuscitation. Research using cardioplegic blood infusion resulted in a 79.4% survival rate with cardiac arrest intervals of 72±43 minutes, traditional methods achieve a 15% survival rate in this scenario, by comparison. New research is currently needed to determine what role CPR, electroshock, and new advanced gradual resuscitation techniques will have with this new knowledge\cite{51}. A notable exception is cardiac arrest occurring in conjunction with exposure to very cold temperatures. Hypothermia seems to protect by slowing down metabolic and physiologic processes, greatly decreasing the tissues' need for oxygen\cite{52}. There are cases where CPR, defibrillation, and advanced warming techniques have revived victims after substantial periods of hypothermia\cite{53}.

**Society and culture**

**Portrayed effectiveness**

CPR is often severely misrepresented in movies and television as being highly effective in resuscitating a person who is not breathing and has no circulation. A 1996 study published in the New England Journal of Medicine showed that CPR success rates in television shows was 75% for immediate circulation, and 67% survival to discharge\cite{54}\cite{55}. This gives members of the public an unrealistic expectation of a successful outcome\cite{54}. When educated on the actual survival rates, the proportion of patients over 60 years of age...
desiring CPR should they suffer a cardiac arrest drops from 41% to 22%. [56]

**Stage CPR**

Chest compressions are capable of causing significant local blunt trauma, including bruising or fracture of the sternum or ribs. [57] Performing CPR on a healthy person may or may not disrupt normal heart rhythm, but regardless the technique should not be performed on a healthy person because of the risk of trauma.

The portrayal of CPR technique on television and film often is purposely incorrect. Actors simulating the performance of CPR may bend their elbows while appearing to compress, to prevent force from reaching the chest of the actor portraying the victim. Other techniques, such as substituting a mannequin torso for the "victim" in some shots, may also be used to avoid harming actors.

**Self-CPR hoax**

A form of "self-CPR" termed "Cough CPR" was the subject of a hoax chain e-mail entitled "How to Survive a Heart Attack When Alone" which wrongly cited "ViaHealth Rochester General Hospital" as the source of the technique. Rochester General Hospital has denied any connection with the technique. [58][59]

Rapid coughing has been used in hospitals for brief periods of cardiac arrhythmia on monitored patients. One researcher has recommended that it be taught broadly to the public. [60][61]

However, “cough CPR” cannot be used outside the hospital because the first symptom of cardiac arrest is unconsciousness [62] in which case coughing is impossible, although myocardial infarction (heart attack) may occur to give rise to the cardiac arrest, so a patient may not be immediately unconscious. Further, the vast majority of people suffering chest pain from a heart attack will not be in cardiac arrest and CPR is not needed. In these cases attempting “cough CPR” will increase the workload on the heart and may be harmful. When coughing is used on trained and monitored patients in hospitals, it has only been shown to be effective for 90 seconds. [63]

The American Heart Association (AHA) and other resuscitation bodies [63] do not endorse "Cough CPR", which it terms a misnomer as it is not a form of resuscitation. The AHA does recognize a limited legitimate use of the coughing technique: "This coughing technique to maintain blood flow during brief arrhythmias has been useful in the hospital, particularly during cardiac catheterization. In such cases the patients ECG is monitored continuously, and a physician is present." [64]

**CPR learned from movies and television**

In at least one case, it has been claimed that CPR allegedly learned from a movie was used to save a person's life. In April 2011, it was claimed that nine-year-old Tristin Saghin saved his sister's life by administering CPR on her after she fell into a swimming pool, using only the knowledge of CPR that he had gleaned from a motion picture, *Black Hawk Down*. [65]

**History**

*Main article: History of CPR*
In the 19th century, Doctor H. R. Silvester described a method (The Silvester Method) of artificial respiration in which the patient is laid on their back, and their arms are raised above their head to aid inhalation and then pressed against their chest to aid exhalation.[66] The procedure is repeated sixteen times per minute. This type of artificial respiration is occasionally seen in films made in the early part of the 20th century.

A second technique, called the Holger Neilson technique, described in the first edition of the Boy Scout Handbook in the United States in 1911, described a form of artificial respiration where the person was laid on their front, with their head to the side, resting on the palms of both hands. Upward pressure applied at the patient’s elbows raised the upper body while pressure on their back forced air into the lungs, essentially the Silvester Method with the patient flipped over. This form is seen well into the 1950s (it is used in an episode of Lassie during the Jeff Miller era), and was often used, sometimes for comedic effect, in theatrical cartoons of the time (see Tom and Jerry's "The Cat and the Mermouse"). This method would continue to be shown, for historical purposes, side-by-side with modern CPR in the Boy Scout Handbook until its ninth edition in 1979. The technique was later banned from first-aid manuals in the UK.

However, it was not until the middle of the 20th century that the wider medical community started to recognize and promote artificial respiration combined with chest compressions as a key part of resuscitation following cardiac arrest. The combination was first seen in a 1962 training video called "The Pulse of Life" created by James Jude, Guy Knickerbocker and Peter Safar. Jude and Knickerbocker, along with William Kouwenhoven and Joseph S. Redding had recently discovered the method of external chest compressions, whereas Safar had worked with Redding and James Elam to prove the effectiveness of artificial respiration. It was at Johns Hopkins University where the technique of CPR was originally developed. The first effort at testing the technique was performed on a dog by Redding, Safar and JW Perason. Soon afterward, the technique was used to save the life of a child.[67] Their combined findings were presented at annual Maryland Medical Society meeting on September 16, 1960 in Ocean City, and gained rapid and widespread acceptance over the following decade, helped by the video and speaking tour they undertook. Peter Safar wrote the book ABC of resuscitation in 1957. In the U.S., it was first promoted as a technique for the public to learn in the 1970s.[68]

Artificial respiration was combined with chest compressions based on the assumption that active ventilation is necessary to keep circulating blood oxygenated, and the combination was accepted without comparing its effectiveness with chest compressions alone. However, research over the past decade has shown that assumption to be in error, resulting in the AHA's acknowledgment of the effectiveness of chest compressions alone (see Cardiocerebral resuscitation in this article).[69]

**In other animals**

It is feasible to perform CPR on animals, including cats and dogs. The principles and practices are virtually identical to CPR for humans. One difference is that resuscitation is usually done through the animal's nose, not the mouth. One is cautioned to only perform CPR on unconscious animals to avoid the risk of being bitten and
that animals, depending on species, have a lower bone density than humans, causing bones to become weakened after CPR is performed.\[70\]

References


2. \^\ European Resuscitation Council (2005). "Guidelines for resuscitation", Part 2, "Adult basic life support": "The following is a summary of the evidence-based recommendations for the performance of basic life support: Rescuers begin CPR if the victim is unconscious, not moving, and not breathing (ignoring occasional gasps).[...]", available at https://www.erc.edu/index.php/guidelines_download_2005/en/


8. \^\ First Aid Manual. St John Ambulance, St Andrews Ambulance and British Red Cross.


12. \^1\ (http://emergency-medicine.jwatch.org/cgi/content/full/2011/304/1?q=etoc_jwem)

13. \^ab\ Cave DM, Gazmuri RJ, Otto CW, et al. (November 2010). "Part 7: CPR techniques and devices: 2010


38. Boyle, Andrew J; Wilson, Andrew M; Connelly, Kim; McGuigan, Louisa; Wilson, Jenny; Whitbourn, Robert (March 2002). "CPREzy: an evaluation during simulated cardiac arrest on a hospital bed". Resuscitation 54 (2002).


41. Rubertsson et al. (2006). "Increased restoration of spontaneous circulation after cardiac arrest with the LUCAS device compared to manual chest compressions". Resuscitation 69.


43. Hallstrom, Al; Rea, Thomas; Sayre, Michael; Christenson, James; Anton, Andy; Mosesso, Vince; Ottingham, Lois; Olsufka, Michele; Pennington, Sarah; White, Lynn; Yahn, Stephen; Husar, James; Morris, Mary; Cob, Leonard. "Manual chest compression vs use of an automated chest compression device during resuscitation following out-of-hospital cardiac arrest" (http://jama.ama-assn.org/cgi/reprint/jama;295/22/2620.pdf?ijkey=V960x0wfyGibF&keytype=finite) (PDF). Journal of the American Medical Association 295 (22). http://jama.ama-assn.org/cgi/reprint/jama;295/22/2620.pdf?ijkey=V960x0wfyGibF&keytype=finite.


68. ^ See, e.g., "Award of the Heart", TIME magazine, November 28, 1973, retrieved on 05-28-2008 from time.com


### External links

- The Center for Resuscitation Science at the Hospital of the University of Pennsylvania (http://www.med.upenn.edu/resuscitation/)
- 2005 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care (http://circ.ahajournals.org/content/vol112/24_suppl/)
- ERC European Resuscitation Council (http://www.erc.eu/)
- Learn CPR - University of Washington (http://depts.washington.edu/learncpr/)
- Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine (http://www.sjtrem.com/)
- How to resuscitate a child (http://www.nhs.uk/Planners/birthtofive/Pages/Howtoresuscitate.aspx) : NHS Choices
- Sarver Heart Center's Continuous Chest Compression CPR on YouTube (http://medicine.arizona.edu/spotlight/learn-sarver-heart-centers-continuous-chest-compression-cpr)


Categories: Emergency medical procedures | First aid

- This page was last modified on 7 June 2011 at 18:10.
- Text is available under the Creative Commons Attribution-ShareAlike License; additional terms may apply. See Terms of Use for details.
- Wikipedia® is a registered trademark of the Wikimedia Foundation, Inc., a non-profit organization.