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Before starting CPR, try to get medical help. Call 911 or your local emergency service number. The dispatcher can guide you through the CPR steps until paramedics arrive. Ask someone nearby to get an automated externaldefibrillator(AED).Next, think of ABC to see if the person needs CPR:A is for AIRWAY. Tilt the persons head back while theyre lying on their back. Look in their mouth and throat to see if theres anything in it (if so, they could be choking).B is for BREATHING. Lean in close to their face and listen for 10 seconds to see if you hear them breathing. Look to see if their chest is going up and down.C is for CIRCULATION. Check for a pulse. Feel the side of their neck just below their jawline for a few seconds.Perform CPR if theres no breathing and no pulse.Learn how to perform CPR.How to do CPRCPR consists of chest compressions and rescue breaths. You can only do chest compressions if thats what youre most comfortable with.Chest compressions (hands-only CPR)CPR starts with chest compressions:Put one of your hands over the other and place them in the middle of the persons chest (slightly under their nipples). If youre helping a child up to age 8, use one hand and place it right above the bottom of their breastbone.With the force of your body weight behind it, push your hands down hard in the middle of their chest for a second. Use the heel of your hand or the part just before your wrist. Keep your elbows straight.Repeatedly push on the persons chest (chest compressions) 100 to 120 times per minute.While giving compressions:Push down 2 inches each time (about the height or short side of a credit card).Make sure you allow their chest to come all the way back up between compressions.It can be easier to remember the compression rate if you follow the beat of songs like Stayin Alive by the Bee Gees or Crazy in Love by Beyonc and Jay-Z.Giving chest compressions can get very tiring very quickly. If other people are around, have them switch places with you to continue the compressions when you run out of energy.Its OK to only do chest compressions (hands-only CPR).Giving rescue breathsIf you have CPR training, you can pause compressions to give the person two mouth-to-mouth rescue breaths. Give two breaths for every 30 compressions (about 20 seconds or so).Pinch their nose closed while tilting their head back a little and their chin up.Close your mouth over theirs and blow a normal-sized breath into it. Their chest should go up. If the persons chest doesnt come up, check to see if theres something in their mouth. Give a total of two breaths and go back to doing compressions.Keep doing chest compressions and giving rescue breaths in a cycle until the person revives or more help arrives.While youre doing CPR, someone should be bringing an AED to use to help with resuscitating the person.Do you continue CPR during breaths?During rescue breaths, you pause chest compressions for a few seconds. After two rescue breaths, you resume the chest compressions.How long should I do CPR?You should keep doing CPR until the person starts breathing or aparamedicarrives. If you get tired, another person can switch places with you.How can CPR save a life?CPR can save a persons life if they receive it right after going into cardiac arrest. CPR can keep blood moving through a persons body. This may prevent organ damage, like cerebral hypoxia.About 1 in 4 people who get prompt CPR in a hospital survive and go home after a hospital stay. About 1 in 10 people who get CPR after a cardiac arrest in a non-hospital setting survive. Still, its worth attempting CPR when someones in cardiac arrest. The best odds happen with consistent CPR for as long as it takes.What are the risks of CPR?CPR comes with risks because of how hard the chest compressions have to be to keep blood circulating. Its possible to break ribs and injure organs within the chest during CPR. But this risk is worth it to try to save a persons life.Some people with certain preexisting health conditions might not experience the same benefits from CPR, depending on how sick they are before they go into cardiac arrest. If you have a significant or severe medical condition, consider speaking with a healthcare provider you trust about what your recovery or outlook might look like if you needed CPR.Which Class is Right for Me?Welcome to CPR Test Center, your official Testing Destination for CPR certification and compliance. For over 12 years CPR Test Center has been delivering top-tier training with techniques created by Dr. Gordon A. Ewy and Dr. Karl B. Kern at the Sarver Heart Center. We've earned our reputation as a trusted leader in CPR, AED, First Aid, Basic Life Support, OSHA 1910.1030, and Bloodborne Pathogens training. Our flexible options make learning easy, and we adhere to the nationally recognized procedures set by the International Liaison Committee on Resuscitation (ILCOR). These methods are used by big names like the American Red Cross and the American Heart Association (AHA), so you know you're getting the best training possible.We're fully accredited by the eCPRVerify National Registry, so you know you're in good hands.We've got flexible training options that fit your schedule, and we stick to the tried-and-true guidelines set by the International Liaison Committee On Resuscitation (ILCOR). Our CPR course awards you 2.5 PDU Professional Development Course Credits (3.5 PDU for BLS for Healthcare Providers). Get certified, make a difference, and level up your skills!At CPR Test Center, we believe learning life-saving CPR techniques should be accessible to everyone. So our training courses are totally free! No strings attached. However, if you're looking to get officially certified, there's a small fee to cover the admin, registration, and digital services for your CPR card and certificate. It's just a one-time payment: $24.99 for the CPR/AED/First Aid Certificate and $34.99 for the BLS for Healthcare Providers Certificate. Both certificates last for 2 years, and that's it. No hidden fees, no ongoing payments. Start saving lives without the stress! Cardiopulmonary resuscitation (CPR) is a hands-on emergency intervention used to restore heartbeats and breathing in someone who has gone into cardiac arrest. Common causes of cardiac arrest are a heart attack or near-drowning. CPR involves manual chest compressions and, in some cases, rescue ("mouth-to-mouth") breathing. If available, a device called an automated external defibrillator (AED) may be used to restore normal heart rhythm. These interventions can keep blood flowing to the brain until emergency medical assistance arrives. This article provides steps for performing CPR on an adult, child, or baby. It also describes how rescue breathing is done and how to use an AED. Cardiopulmonary resuscitation (CPR) is used on someone with cardiac arrest. This is when the heart stops beating, causing the person to collapse, lose consciousness, and stop breathing. By applying external pressure on the chest, you can manually pump the heart and keep blood flowing until emergency help arrives. CPR can be performed on people of any age. CPR is needed when a person has the four signs of cardiac arrest:The person has collapsed.The person is non-responsive.Breathing has stopped.There is no pulse. Performing CPR on someone with cardiac arrest doubles or triples their chances of survival. Before starting CPR: Make sure that you and the victim are well away from traffic, fire, or any other hazard.Ask the person loudly if they are OK to see if they are responsive.If not, call 911 or ask a bystander to do so.If available, ask someone to get or find an AED (often available in public facilities).Turn the person on their back and check if they are breathing by listening for breathing sounds or seeing if their chest rises and falls. All of these tasks can be performed in less than a minute.A rapid response is needed as permanent brain damage can occur after onlyfour minuteswithout oxygen. Death can occur as soon as four to six minutes later. CPR procedures vary based on the age of the victim as well as the training of the person performing CPR. According to the American Heart Association:CPR with rescue breaths can be performed if you are formally trained in CPR.Hands-only CPR is recommended if you have no CPR training or are not confident in your skills. Illustration by Tara Anand for Verywell Health The following steps apply to adults and children over 8 years old: Place one hand on the middle of the persons chest just below the nipples. Place the other hand on top, locking fingers.Using your body weight, push hard with the heel of your hand. You need to push hard enough to compress the chest to a depth of around 2 inches. Keep your arms straight.Keep compressing at a rate of 100 to 120 beats per minute. The easiest way to do so is by pushing to the rhythm of the Bee Gee's "Staying Alive," Johnny Cash's "Ring of Fire," or Beyonce's "Crazy in Love."If you are qualified to give rescue breaths, do 30 chest compressions followed by two rescue breaths, followed by another set of chest compressions, and so on. If you are not, keep doing chest compressions without rescue breaths.If another person is available to help, they can take over if you get tired. Continue until emergency medical help arrives or the person revives. The procedure for givingCPRto a child is essentially the same as that for an adult. For a small child: Place the heel of one hand in the middle of the small childs chest on the breastbone.For a child: Place the heel of one hand in the center of the child's chest, with your other hand on top, with fingers interlaced and fingers off of the child's chest.Push hard with your hand, compressing the chest to a depth of around 2 inches.Keep compressing at a rate of 100 to 120 beats per minute.If you are qualified to give rescue breaths, do 30 chest compressions, followed by two rescue breaths, followed by another set of chest compressions, and so on. If not, keep doing chest compressions without rescue breaths. Continue until emergency medical help arrives or the child revives. With infants, check for responsiveness by flicking the bottom of their foot. If the infant is non-responsive and there are no signs of breathing, proceed as follows: Place two fingers in the center of the infant's chest.Firmly compress the chest about 1-1/2 inches deep at a rate of around 120 beats per minute.If you are qualified to give rescue breaths, do 30 chest compressions, followed by two rescue breaths, followed by another set of chest compressions, and so on. If, do chest compressions without rescue breaths. Continue until emergency medical help arrives or the infant revives. Illustration by Tara Anand for Verywell Health Rescue breathing is not advised for people untrained in CPT because it is not proven to save lives. Doing so may put the person at risk by interrupting the flow of blood to the brain. If you are skilled in CPR, adding rescue breaths ensures that the person's blood is oxygenated and the blood flow is sufficient. If you are not skilled and end up doing one or both procedures insufficiently, you may put the person at risk. Rescue breathing is performed as follows: Check that the person's mouth is clear. If there is a visible obstruction, try to fish it out with your fingers.Tilt the person's head back slightly and lift their chin.Pinch their nose shut.Place your mouth fully over theirs.Blow forcefully to make their chest rise. If their chest does not rise, tilt their head back a little further and try again. Rescue breathing is slightly different for infants: Check that the infant's mouth is clear. If there is a visible obstruction, try to fish it out with a finger.Tilt the infant's head back slightly and lift their chin.Place your mouth fully over their nose and mouth.Blow forcefully to make their chest rise. If their chest does not rise, tilt their head back a little further and try again. Automatic external defibrillators (AEDS) are used for abnormal heartbeats, with a strong pulse of electricity. Using an AED within the first three to five minutes of cardiac arrest dramatically increases the survival rate. AEDs are frequently installed in public facilities in the event someone experiences cardiac arrest. In such situations, there should be someone in the facility trained in CPR and AED use. While an AED is relatively easy to use, there are many different models, and the American Heart Association advises that only people formally trained in CPR and AED use them. Children over 8 years can be treated with a standard AED. Children age 1 to 8 years require special defibrillator pads. AEDs are not used on children under 1 year of age or on someone with a pulse. You can get certified in CPR by meeting the requirements of a CPR training program. These programs are offered in-person, online, or as a hybrid of both. Once you have completed the class, you will be given a certificate. CPR training courses are offered by hospitals, community centers, and national organizations such as the American Red Cross and the American Heart Association. Not every CPR class is the same. There are CPR classes for healthcare professionals as well as CPR classes for the layperson. Before you take a CPR class, make sure the class is right for you.Emergency procedure after sudden cardiac arrest"CPR" redirects here. For other uses, see CPR (disambiguation).Medical interventionCardiopulmonary resuscitationCPR being performed on a medical-training mannequinSpecialtyCardiology, emergency medicine, critical care medicineICD-999.60MeSHD016887OPS-301code8-771MedlinePlus000010[edit on Wikidata]Cardiopulmonary resuscitation (CPR) is an emergency procedure used during cardiac or respiratory arrest that involves chest compressions, often combined with artificial ventilation, to preserve brain function and maintain circulation until spontaneous breathing and heartbeat can be restored. It is recommended for those who are unresponsive with no breathing or abnormal breathing, for example, agonal respirations.[1]CPR involves chest compressions for adults between 5cm (2.0in) and 6cm (2.4in) deep and at a rate of at least 100 to 120 per minute.[2] The rescuer may also provide artificial ventilation by either exhaling air into the subject's mouth or nose (mouth-to-mouth resuscitation) or using a device that pushes air into the subject's lungs (mechanical ventilation). Current recommendations emphasize early and high-quality chest compressions over artificial ventilation; a simplified CPR method involving only chest compressions is recommended for untrained rescuers.[3] With children, however, 2015 American Heart Association guidelines indicate that doing only compressions may result in worse outcomes, because such problems in children normally arise from respiratory issues rather than from cardiac ones, given their young age.[1] Chest compression to breathing ratios are set at 30 to 2 in adults.CPR alone is unlikely to restart the heart. Its main purpose is to restore the 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 to restore a viable, or "perfusing", heart rhythm. Defibrillation is effective only for certain heart rhythms, namely ventricular fibrillation or pulseless ventricular tachycardia, rather than asystole or pulseless electrical activity, which usually requires the treatment of underlying conditions to restore cardiac function. Early shock, when appropriate, is recommended. CPR may succeed in inducing a heart rhythm that may be shockable. In general, CPR is continued until the person has a return of spontaneous circulation (ROSC) or is declared dead.[4]Welsh Government training video of how to perform CPR on a person in cardiac arrestCPR is indicated for any person unresponsive with no breathing or breathing only in occasional agonal gasps, as it is most likely that they are in cardiac arrest.[5]:S643 If a person still has a pulse but is not breathing (respiratory arrest), artificial ventilations 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 healthcare professionals the option to check a pulse.[6] In those with cardiac arrest due to trauma, CPR is considered futile but still recommended.[7] Correcting the underlying cause such as a tension pneumothorax or pericardial tamponade may help.[7]CPR is used on people in cardiac arrest 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 physiology of CPR involves generating a pressure gradient between the arterial and venous vascular beds; CPR achieves this via multiple mechanisms.[8]The brain may sustain damage after blood flow has been stopped for about four minutes and irreversible damage after about seven minutes.[9][10][11][12][13] Typically if blood flow ceases for one to two hours, then body cells die. Therefore, in general, CPR is effective only if performed within seven minutes of the stoppage of blood flow.[14] 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 stem death and allows the heart to remain responsive to defibrillation attempts.[15] If an incorrect compression rate is used during CPR, going against standing American Heart Association (AHA) guidelines of 100120 compressions per minute, this can cause a net decrease in venous return of blood, for what is required, to fill the heart.[16] For example, if a compression rate of above 120 compressions per minute is used consistently throughout the entire CPR process, this error could adversely affect survival rates and outcomes for the victim.[16]The best position for CPR maneuvers in the sequence of first aid reactions to a cardiac arrest is a question that has been long studied.[17][18]As a general reference, the recommended order (according to the guidelines of many related associations such as AHA and Red Cross) is:Asking for help from bystanders in case any of them have received first aid training or can perform additional tasks.Variation: when the rescuer is alone and no phone is nearby, the rescuer would go first for a phone to call for emergency medical services [17] (only if the rescuer can return in very few minutes to apply CPR maneuvers to the patient, or emergency medical services will be with the patient in a few minutes).Calling by phone for emergency medical services. Also, go for an automated defibrillator (AED), but only if the AED is available within a few minutes.Attempting defibrillation with the automated external defibrillator (AED), because it is easy to use if it has been found. If not, or until it has arrived, attempting CPR maneuvers as the latest step of those possible ones.If there are multiple rescuers, these tasks can be distributed and performed simultaneously to save time.If a rescuer is completely alone with a victim of drowning, or with a child who was already unconscious when the rescuer arrived, the rescuer should:First perform two minutes of CPR maneuvers.Variation: when the lone rescuer does not have a phone, it is recommended to perform about two minutes of CPR maneuvers, and then go for a phone to call for emergency medical services[17] (only if the rescuer can return in very few minutes to continue the CPR maneuvers, or emergency medical services will be with the patient in a few minutes).Call by phone for emergency medical services. Also, go for an automated defibrillator (AED), but only if the AED is available within a few minutes.Attempt defibrillation with the automated external defibrillator (AED), because it is easy to use if it has been found. If not, or until it has arrived, attempt CPR maneuvers as the latest step of those possible ones.The reason is that CPR ventilation (rescue breaths) is considered the most important action for those victims. Cardiac arrest in drowning victims originates from a lack of oxygen, and a child would probably not suffer from cardiac diseases.[19]CPR training: CPR is being administered while a second rescuer prepares for defibrillation.In 2010, the AHA and International Liaison Committee on Resuscitation updated their CPR guidelines.[5]:S640[20] The importance of high quality CPR (sufficient rate and depth without excessively ventilating) was emphasized.[5]: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).[5]:S642 An exception to this recommendation is for those believed to be in a respiratory arrest (airway obstruction, drug overdose, etc.).[5]:S642The most important aspects of CPR are: few interruptions of chest compressions, sufficient speed and depth of compressions, completely relaxing pressure between compressions, and not ventilating too much.[21] It is unclear if a few minutes of CPR before defibrillation results in different outcomes than immediate defibrillation.[22]A normal CPR procedure uses chest compressions and ventilations (rescue breaths, usually mouth-to-mouth) for any victim of cardiac arrest, who would be unresponsive (usually unconscious or approximately unconscious), not breathing, or only gasping because of the lack of heartbeats.[23] But the ventilations could be omitted[24] for untrained rescuers aiding adults who suffer a cardiac arrest (if it is not an asphyxial cardiac arrest, as by drowning, which needs ventilations).[25]Chest compressions performed at 100 per minute (proper rhythm)The patient's head is commonly tilted back (a head-tilt and chin-lift position) for improving the airflow if ventilations can be used. However, when a patient seems to have a possible serious injury in the spinal cord (in the backbone, either at the neck part or the back part), the head must not be moved except if that is completely necessary, and always very carefully, which avoids further damages for the patient's mobility in the future.[26] And, in the case of babies, the head is left straight, looking forward, which is necessary for the ventilations, because of the size of the baby's neck.[27]Mouth-to-mouth ventilations (mouth-to-mouth rescue breaths) In CPR, the chest compressions push on the lower half of the sternum the bone that is along the middle of the chest from the neck to the belly and leave it to rise up until recovering its normal position. The rescue breaths are made by pinching the victim's nose and blowing air mouth-to-mouth. This fills the lungs, which makes the chest rise up, and increases the pressure into the thoracic cavity. If the victim is a baby, the rescuer would compress the chest with only 2 fingers and would make the ventilations using their own mouth to cover the baby's mouth and nose at the same time. The recommended compression-to-ventilation ratio, for all victims of any age, is 30:2 (a cycle that alternates continually 30 rhythmic chest compressions series and 2 rescue breaths series).[28]:8 Victims of drowning receive an initial series of 2 rescue breaths before that cycle begins.[29]As an exception for the normal compression-to-ventilation ratio of 30:2, if at least two trained rescuers are present and the victim is a child, the preferred ratio is 15:2.[30]:8 Equally, in newborns, the ratio is 30:2 if one rescuer is present, and 15:2 if two rescuers are present (according to the AHA 2015 Guidelines).[5]:S647 In an advanced airway treatment, such as an endotracheal tube or laryngeal mask airway, the artificial ventilation should occur without pauses in compressions at a rate of 1 breath every 6 to 8 seconds (810 ventilations per minute).In all victims, the compression speed is at least 100 compressions per minute.[31]:8 Recommended compression depth in adults and children is of 5cm (2 inches), and in infants it is 4cm (1.6 inches).[31]:8 In adults, rescuers should use two hands for the chest compressions (one on top of the other), while in children one hand could be enough (or two, adapting the compressions to the child's constitution), and with babies the rescuer must use only two fingers.[32]There exist some plastic shields and respirators that can be used in the rescue breaths between the mouths of the rescuer and the victim, with the purposes of sealing a better vacuum and avoiding infections.[33]In some cases, the problem is one of the failures in the rhythm of the heart (ventricular fibrillation and ventricular tachycardia) that can be corrected with the electric shock of a defibrillator. So, if a victim is suffering a cardiac arrest, it is important that someone asks for a defibrillator nearby, to try with it a defibrillation process when the victim is already unconscious. The common model of a defibrillator (the AED) is an automatic portable machine that guides the user with recorded voice instructions along the process, analyzes the victim, and applies the correct shocks if they are needed.The time in which a cardiopulmonary resuscitation can still work is unclear, and it depends on many factors. Many official guides recommend continuing cardiopulmonary resuscitation until emergency medical services arrive (for trying to keep the patient alive, at least).[26] The same guides also indicate asking for any emergency defibrillator (AED) near, to try an automatic defibrillation as soon as possible before considering that the patient has died.[26]A normal cardiopulmonary resuscitation has a recommended order named 'CAB': first 'Chest' (chest compressions), followed by 'Airway' (attempt to open the airway by performing a head tilt and a chin lift), and 'Breathing' (rescue breaths).[5]:S642 As of 2010, the Resuscitation Council (UK) was still recommending an 'ABC' order, with the 'C' standing for 'Circulation' (check for a pulse), if the victim is a child.[34] It can be difficult to determine the presence or absence of a pulse, so the pulse check has been removed for common providers and should not be performed for more than 10 seconds by healthcare providers.[25]:8For untrained rescuers helping adult victims of cardiac arrest, it is recommended to perform compression-only CPR (chest compressions hands-only or cardiocerebral resuscitation, without artificial ventilation), as it is easier to perform and instructions are easier to give over a phone.[24][5]:S643[5]:S643[35]:8[36] In adults with out-of-hospital cardiac arrest, compression-only CPR by the average person has an equal or higher success rate than standard CPR.[36][37][38]CPR technique as demonstrated on a dummyThe CPR 'compressions only' procedure consists only of chest compressions that push on the lower half of the bone that is in the middle of the chest (the sternum).Compression-only CPR is not as good for children who are more likely to have cardiac arrest from respiratory causes. Two reviews have found that compression-only CPR had no more success than no CPR whatsoever.[37][5]:S646 Rescue breaths for children and especially for babies should be relatively gentle.[37] Either a ratio of compressions to breaths of 30:2 or 15:2 was found to have better results for children.[39] Both children and adults should receive 100 chest compressions per minute. Other exceptions besides children include cases of drownings and drug overdose; in both these cases, compressions, and rescue breaths are recommended if the bystander is trained and is willing to do so.[40]As per the AHA, the beat of the Bee Gees song "Stayin' Alive" provides an ideal rhythm in terms of beats per minute to use for hands-only CPR, which is 104 beats-per-minute.[41] One can also hum Queen's "Another One Bites the Dust", which is 110 beats-per-minute[42][43] and contains a repeating drum pattern.[44] For those in cardiac arrest due to non-heart related causes and in people less than 20 years of age, standard CPR is superior to compression-only CPR.[45][46]Supine and prone positionsStandard CPR is performed with the victim in supine position. Prone CPR, or reverse CPR, is performed on a victim in prone position, lying on the chest. This is achieved by turning the head to the side and compressing the back. Due to the head being turned, the risk of vomiting and complications caused by aspiration pneumonia may be reduced.[47]The American Heart Association's current guidelines recommend performing CPR in the supine position and limiting prone CPR to situations where the patient cannot be turned.[48]During pregnancy when a woman is lying on her back, the uterus may compress the inferior vena cava and thus decrease venous return.[7] It is therefore recommended that the uterus be pushed to the woman's left. This can be done by placing a pillow or towel under her right hip so that she is on an angle of 1530 degrees, and making sure their shoulders are flat to the ground. If this is not effective, healthcare professionals should consider emergency resuscitative hysterotomy.[7]Evidence generally supports family being present during CPR.[49] This includes in CPR for children.[50]Interposed abdominal compressions may be beneficial in the hospital environment.[51] There is no evidence of benefit pre-hospital or in children.[51]Cooling during CPR is being studied as currently, results are unclear whether or not it improves outcomes.[52]Internal cardiac massage is the manual squeezing of the exposed heart itself carried out through a surgical incision into the chest cavity, usually when the chest is already open for cardiac surgery.Active compression-decompression methods using mechanical decompression of the chest have not been shown to improve outcomes in cardiac arrest.[53]A defibrillator is a machine that produces defibrillation: electric shocks that can restore the normal heart function of the victim. The common model of a defibrillator out of a hospital is the automated external defibrillator (AED), a portable device that is especially easy to use because it produces recorded voice instructions.A briefcase with a public defibrillator, at a station. Its universal symbol appears above.Automated defibrillator (AED)Defibrillation is only indicated for some arrhythmias (abnormal heart beatings), specifically ventricular fibrillation (VF) and pulseless ventricular tachycardia (VT). Defibrillation is not indicated if the patient has a normal pulse or is still conscious. Also, it is not indicated in asystole or pulseless electrical activity (PEA), in those cases a normal CPR would be used to oxygenate the brain until the heart function can be restored. Improperly given electrical shocks can cause dangerous arrhythmias, such as the ventricular fibrillation (VF).[22]When a patient does not have heart beatings (or they present a sort of arrhythmia that will stop the heart immediately), it is recommended that someone asks for a defibrillator (because they are quite common in the present time),[17] for trying with it a defibrillation on the already unconscious victim, in case it is successful.Order of defibrillation in a first aid sequenceIt is recommended to call for emergency medical services before a defibrillation. Afterward, a nearby AED defibrillator should be used on the patient as soon as possible. As a general reference, defibrillation is preferred to performing CPR, but only if the AED can be retrieved in a short period of time. All these tasks (calling by phone, getting an AED, and the chest compressions and rescue breaths maneuvers of CPR) can be distributed between many rescuers who make them simultaneously.[19] The defibrillator itself would indicate if more CPR maneuvers are required.As a slight variation for that sequence, if the rescuer is completely alone with a victim of drowning, or with a child who was already unconscious when the rescuer arrived, the rescuer would do the CPR maneuvers during 2 minutes (approximately 5 cycles of ventilations and compressions); after that, the rescuer would call to emergency medical services, and then it could be tried a search for a defibrillator nearby (the CPR maneuvers are supposed to be the priority for the drowned and most of the already collapsed children).[54][19][17][18]As another possible variation, if a rescuer is completely alone and without a phone nearby, and is aiding any other victim (not a victim of drowning, nor an already unconscious child), the rescuer would go to call by phone first. After the call, the rescuer would get a nearby defibrillator and use it, or continue the CPR (the phone call and the defibrillator are considered urgent when the problem has a cardiac origin).[17]DefibrillationDefibrillation: position of the electrodes of a defibrillator on the human bodyThe standard defibrillation device, prepared for fast use out of the medical centers, is the automated external defibrillator (AED), a portable machine of small size (similar to a briefcase) that can be used by any user with no previous training. That machine produces recorded voice instructions that guide the user along the defibrillation process. It also checks the victim's condition to automatically apply electric shocks at the correct level, if they are needed. Other models are semi-automatic and require the user to push a button before an electric shock.A defibrillator may ask for applying CPR maneuvers, so the patient would be placed lying in a face-up position. Additionally, the patient's head would be tilted back, except in the case of babies.[27]Water and metals transmit the electric current. This depends on the amount of water, but it is convenient to avoid starting the defibrillation on a floor with puddles and to dry the wet areas of the patient before (fast, even with any cloth, if that is enough). It is not necessary to remove the patient's jewels or piercings, but it should be avoided placing the patches of the defibrillator directly on top of them.[29] The patches with electrodes are put on the positions that appear at the right. In very small bodies: children between 1 and 8 years, and, in general, similar bodies up to 25kg approximately, it is recommended the use of children's size patches with reduced electric doses. If that is not possible, sizes and doses for adults would be used, and, if the patches were too big, one would be placed on the chest and the other on the back (no matter which of them).There are several devices for improving CPR, but only defibrillators (as of 2010)[55] have been found better than standard CPR for an out-of-hospital cardiac arrest.[5]When a defibrillator has been used, it should remain attached to the patient until emergency services arrive.[56]Timing devices can feature a metronome (an item carried by many ambulance crews) to assist the rescuer in achieving the correct rate. Some units can also give timing reminders for performing compressions, ventilating, and changing operators.[57]The ejection of blood from the heart is conditioned by the compression of the sternum by a third of the height of the chest.Demonstrating a mechanical heart massage device, Vienna, 1967AutoPulseLUCASMechanical chest compression devices are not better than standard manual compressions.[58] Their use is reasonable in situations where manual compressions are not safe to perform, such as in a moving vehicle.[58]Audible and visual prompting may improve the quality of CPR and prevent the decrease of compression rate and depth that naturally occurs with fatigue,[59][60] and to address this potential improvement, a number of devices have been developed to help improve CPR technique.These items can be devices to be 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,[61] or in a wearable format such as a glove.[62] Several published evaluations show that these devices can improve the performance of chest compressions.[63][64]As well as its 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.[65]Mechanical CPR has not seen as much use as mechanical ventilation; however, use in the prehospital setting is increasing.[66] Devices on the market include the LUCAS device,[67] developed at the University Hospital of Lund,[68] and AutoPulse. Both use straps around the chest to secure the patient. The first generation of the LUCAS uses a gas-driven piston and motor-driven constricting band, while later versions are battery-operated.[69]There are several advantages to automated devices: they allow rescuers to focus on performing other interventions; they do not fatigue and begin to perform less effective compressions, as humans do; they can perform effective compressions in limited-space environments such as air ambulances,[70] where manual compressions are difficult, and they allow ambulance workers to be strapped in safely rather than standing over a patient in a speeding vehicle.[71] However the disadvantages are cost to purchase, time to train emergency personnel to use them, interruption to CPR to implement, potential for incorrect application and the need for multiple device sizes.[72][73]Several studies have shown little or no improvement in survival rates[74][75][76] but acknowledge the need for more study.[77]To support training and incident management, mobile apps have been published in the largest app markets. An evaluation of 61 available apps has revealed that a large number do not follow international guidelines for basic life support and many apps are not designed in a user-friendly way.[78] As a result, the Red Cross updated and endorsed its emergency preparedness application, which uses pictures, text, and videos to assist the user.[79] The UK Resuscitation Council has an app, called Lifesaver, which shows how to perform CPR.[80]CPR oxygenates the body and brain, which favors making a later defibrillation and the advanced life support. Even in the case of a "non-shockable" rhythm, such as pulseless electrical activity (PEA) where defibrillation is not indicated, effective CPR is no less important. Used alone, CPR will result in few complete recoveries, though the outcome without CPR is almost uniformly fatal.[81]Studies have shown that immediate CPR followed by defibrillation within 35 minutes of sudden VF cardiac arrest dramatically improves survival. In cities such as Seattle where CPR training is widespread and defibrillation by EMS personnel follows quickly, the survival rate is about 20 percent for all causes and as high as 57 percent for a witnessed "shockable" arrest.[82] In cities such as New York, without those advantages, the survival rate is only 5 percent for witnessed shockable arrest.[83] Similarly, in-hospital CPR is more successful when arrests are witnessed, occur in the ICU, or occur in patients wearing heart monitors.[84][85]Adults' outcomes after CPRCPR in US hospitalsUSA, CPR outside hospitals[86]Total in hospitalsSourceCPR where an AED was used by a bystander*All witnessed arrests with CPR, with or without bystander AEDUnwitnessed arrest with CPRTotal outside hospitalsReturn of spontaneous circulation (ROSC):201849%41.9%20.6%31.3%Survival to hospital discharge:201835%16.2%4.4%10.4%201725.6%page e381,e390, 2019 AHA[87]33%16.4%4.6%10.4%201626.4%p.e365, 2018 AHA32%17.0%4.7%10.8%201523.8%page e471, 2017 AHA[88]32%16.7%4.6%10.6%201424.8%page e270, 2016 AHA[89]32%16.7%4.9%10.8%201316.8%4.7%10.8%2012201122.7%p.499, 2014 AHA[90]2010200918.6%p.12, Girotra supplement[91]200819.4%[91]* AED data here exclude health facilities and nursing homes, where patients are sicker than average.In adults compression-only CPR by bystanders appears to be better than chest compressions with rescue breathing.[92] Compression-only CPR may be 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 117) 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 than did compression-only CPR (OR 5.54). For arrests with a cardiac cause in this cohort, there was no difference between the two techniques (OR 1.20).[93] This is consistent with American Heart Association guidelines for parents.[94]When done by trained responders, 30 compressions interrupted by two breaths appears to have a slightly better result than continuous chest compressions with breaths being delivered while compressions are ongoing.[92]Measurement of end-tidal carbon dioxide during CPR reflects cardiac output[95] and can predict chances of ROSC.[96]In a study of in-hospital CPR from 2000 to 2008, 59% of CPR survivors lived over a year after hospital discharge and 44% lived over 3 years.[97]Survival rates: In US hospitals in 2017, 26% of patients who received CPR survived to hospital discharge.[98]:e381,e390[99]In 2017 in the US, outside hospitals, 16% of people whose cardiac arrest was witnessed survived to hospital discharge.[100]Since 2003, widespread cooling of patients after CPR[101]and other improvements have raised survival and reduced mental disabilities.Organ donation is usually made possible by CPR, even if CPR does not save the patient. If there is a return of spontaneous circulation (ROSC), all organs can be considered for donation. If the patient does not achieve ROSC, and CPR continues until an operating room is available, the kidneys and liver can still be considered for donation.[102]1,000 organs per year in the US are transplanted from patients who had CPR.[103]Donations can be taken from 40% of patients who have ROSC and later become brain-dead.[104]Up to 8 organs can be taken from each donor,[105]and an average of 3 organs are taken from each patient who donates organs.[103]Mental abilities are about the same for survivors before and after CPR for 89% of patients, based on before and after counts of 12,500 US patients' Cerebral-Performance Category (CPC[106]) codes in a 20002009 study of CPR in hospitals. 1% more survivors were in comas than before CPR. 5% more needed help with daily activities. 5% more had moderate mental problems and could still be independent.[107]For CPR outside hospitals, a Copenhagen study of 2,504 patients in 2007-2011 found that 21% of survivors developed moderate mental problems but could still be independent, and 11% of survivors developed severe mental problems, so they needed daily help. Two patients out of 2,504 went into comas (0.1% of patients, or 2 out of 419 survivors, 0.5%), and the study did not track how long the comas lasted.[108]Most people in comas start to recover in 23 weeks.[109] 2018 guidelines on disorders of consciousness say it is no longer appropriate to use the term "permanent vegetative state."[110] Mental abilities can continue to improve in the six months after discharge,[111] and in subsequent years.[109] For long-term problems, brains form new paths to replace damaged areas.[112][113]Injuries from CPR vary. 87% of patients are not injured by CPR.[114] Overall, injuries are caused in 13% (200912 data) of patients, including broken sternum or ribs (9%), lung injuries (3%), and internal bleeding (3%).[114]The internal injuries counted here can include heart contusion,[115] hemopericardium,[116][117][118] upper airway complications, damage to the abdominal viscera lacerations of the liver and spleen, fat emboli, pulmonary complications pneumothorax, hemothorax, lung contusions.[119][120] Most injuries did not affect care; only 1% of those given CPR received life-threatening injuries from it.[114][120]Broken ribs are present in 3%[114]of those who survive to hospital discharge, and 15% of those who die in the hospital, for an average rate of 9% (2009-12 data)[114]to 8% (199799).[121]In the 2009-12 study, 20% of survivors were older than 75.[114] A study in the 1990s found 55% of CPR patients who died before discharge had broken ribs, and a study in the 1960s found 97% did; training and experience levels have improved.[122] Lung injuries were caused in 3% of patients and other internal bleeding in 3% (200912).Bones heal in 12 months.[123][124]The costal cartilage also breaks in an unknown number of additional cases, which can sound like breaking bones.[125][126]The type and frequency of injury can be affected by factors such as sex and age. A 1999 Austrian study of CPR on cadavers, using a machine that alternately compressed the chest and then pulled it outward, found a higher rate of sternal fractures in female cadavers (9 of 17) than males (2 of 20), and found the risk of rib fractures rose with age, though they did not say how much.[127]Children and infants have a low risk of rib fractures during CPR, with an incidence of less than 2%, although, when they do occur, they are usually anterior and multiple.[122][128][129]Where CPR is performed in error by a bystander, on a person not in cardiac arrest, around 2% have injury as a result (although 12% experienced discomfort).[130]A 2004 overview said, "Chest injury is a price worth paying to achieve optimal efficacy of chest compressions. Cautious or faint-hearted chest compression may save bones in the individual case but not the patient's life."[122]The most common side effect is vomiting, which necessitates clearing the mouth so patients do not breathe it in.[131]It happened in 16 of 35 CPR efforts in a 1989 study in King County, Washington.[132]Survival from CPR among various groupsThe American Heart Association guidelines say that survival rates below 1% are "futility,"[133] but all groups have better survival than that. Even among very sick patients, at least 10% survive: A study of CPR in a sample of US hospitals from 2001 to 2010,[84] where overall survival was 19%, found 10% survival among cancer patients, 12% among dialysis patients, 14% over age 80, 15% among blacks, 17% for patients who lived in nursing homes, 19% for patients with heart failure, and 25% for patients with heart monitoring outside the ICU.Another study, of advanced cancer patients, found the same 10% survival mentioned above.[134]A study of Swedish patients in 20072015 with ECG monitors found 40% survived at least 30 days after CPR at ages 7079, 29% at ages 8089, and 27% above age 90.[135]An earlier study of Medicare patients in hospitals from 1992 to 2005, where overall survival was 18%, found 13% survival in the poorest neighborhoods, 12% survival over age 90, 15% survival among ages 8589, and 17% survival among ages 8084.[136]Swedish patients 90 years or older had 15% survival to hospital discharge, 8089 had 20%, and 7079 had 28%.[135]A study of King County WA patients who had CPR outside hospitals in 19992003, where 34% survived to hospital discharge overall, found that among patients with 4 or more major medical conditions, 18% survived; with 3 major conditions 24% survived, and 33% of those with 2 major medical conditions survived.[137]Nursing home residents' survival has been studied by several authors,[84][136][108][138][139][140][141]and is measured annually by the Cardiac Arrest Registry to Enhance Survival (CARES). CARES reports CPR results from a catchment area of 115 million people, including 23 state-wide registries, and individual communities in 18